ROADS And STREETS
Vol. LXVIII Number 11
A GILLETTE PUBLICATION
ESTABLISHED 1906

Completed Surface on Section 4. The Aggregate Was Crusher Run Limestone

BITUMINOUS MAT CONSTRUCTION IN KANSAS

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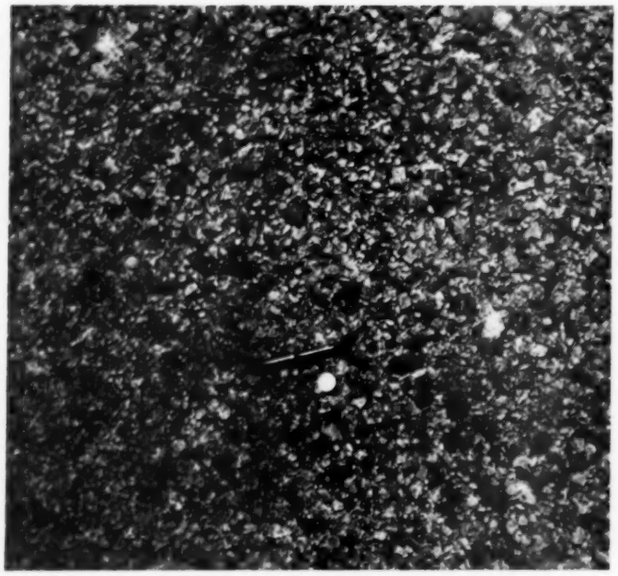
IN the fall of 1930, the Kansas Highway Department constructed its first section of bituminous mat road in Central Kansas. This section, 6.5 miles long, is still in use and, with only routine maintenance, is in good condition after five years of service. Since then, the Department has built mat roads in 73 of the 105 counties of the state, and at the present time, 1,752 miles of highways on the state system are surfaced with bituminous mat, and 1,005 miles have received an oil penetration treatment.

Kansas has always been confronted with the problem of constructing and maintaining a large mileage of highways from a relatively small income. So by force of circumstance, it has been necessary to develop and use low cost local material to construct some intermediate type of surface on many of the roads on the state system. Bituminous mat surfaces of different types, in most cases, have met these requirements, both as to cost and serviceability.

Graded Aggregate Type.—Prior to 1935, all of the mats constructed in Kansas were of the graded aggregate type. Engineers, in selecting the various materials that entered into the construction of this type of mat, endeavored to obtain a finished aggregate that was uniformly graded from coarse to fine and thereby form a mat of maximum density. All of the aggregate passed a 1 in. screen, and the finished mat contained from 8 to 15 per cent fines which passed a 200 mesh screen. The amount of oil used was determined by the "New Mexico" formula and varied from 3½ to 6 per cent, depending on the gradation of the aggregate. Mats of this type were built in every part of the state and laid on all types of subgrade soil. They were subjected to variations of traffic and rainfall and could be studied under almost every condition that is encountered in Kansas.

Coarse Aggregate Type Developed.—In 1934, the engineering department concluded that, under some conditions, a mat of different type might prove more satisfactory both as to cost and serviceability. The average rainfall in Kansas varies from less than 20 in. annually in the western part of the state to more than 40 in. in the southeastern part. There is also a wide variation in subgrade soil; that of the western two-

Close-Up of Graded Aggregate Bituminous Mat



The Open Texture of a Coarse Aggregate Mat Is Shown in This Picture. The Aggregate Was No. 3 Stone, Rolled and Keyed.

thirds of the state is usually sandy, while the eastern third is frequently dense clay or gumbo. The combination of dense and sometimes water-bearing subgrade soil and higher rainfall caused frequent mat failures in eastern Kansas.

Limestone ledges underlaid by dense, impervious beds of clay or shale are numerous in the eastern portion of the state. These ledges are almost always water-bearing and saturate the subgrade which causes a surface failure. This condition is more noticeable if the surfacing material is dense and water-tight.

Material surveys show that whereas local sand-gravel deposits are numerous in Central and Western Kansas, they are infrequent in Eastern Kansas, and where found in this part of the state, are expensive to produce, but ledges of suitable limestone are available in this area, and can be utilized for local production.

With these conditions in mind, an attempt was made to develop an "open type" or coarse aggregate mat which would not tend to entrap moisture and would allow some evaporation of excess moisture in the subgrade and at the same time use available local material.

It was also believed that a coarse aggregate mat would be more stable, due to the interlocking of the larger and rougher particles even though the subgrade did retain excess moisture. Three short sections of road were chosen for experimental purposes, one in the southeastern part of the state, another in the north central part, and the third in central eastern Kansas.

Section 5: Placing Crushed Rock in a Windrow at Rate of 1,200 Cu. Yd. a Mile. The Base Has Been Scarified, Reshaped and Rolled. Excess Material Shown in the Ditch Was Used in the Shoulders After Completion of the Surface.

Subgrade failures caused by rock outcrops and clay soil were numerous in all three cases. Two of the experimental sections had been previously surfaced with a graded aggregate mat and the third with limestone gravel, surface-treated with asphaltic road oil. Maintenance of these sections in the past had been expensive. Because of the similarity of treatment and methods used on these experimental roads, only the details of the central eastern test will be outlined here.

General Conditions of Experimental Section.—For the purposes of this experiment, a portion of U. S. 75, one and three-quarters miles long, was selected. Traffic surveys indicated that this section served 755 vehicles daily. This road had been surfaced in 1932 with a graded aggregate bituminous mat and, due to a combination of rock ledges and unstable clay subgrade, had been difficult to maintain. The road was divided into seven test sections, each ¼ mile long. Stone at the rate of 1,200 tons a mile was used on each section, and various combinations of asphalts and aggregate were used as hereinafter indicated. For convenience, the specifications for the various types of cutback asphalt are arranged in tabular form in Table I, and the stone gradations are shown in Table II. The detailed construction methods and treatments used on each section follow.

TABLE I—KANSAS SPECIFICATIONS FOR THE CUTBACK ASPHALTS USED IN THE EXPERIMENTAL SECTIONS

Test	RC–2	MC–2	MC–3	MC–4
Flash points (°F.)	80+	150+	150+	150+
Furol viscosity at 122° F.	200–400	.....	.....	.....
Furol viscosity at 140° F.	.....	150–250	300–500	500–800
Distillation, per cent by volume:				
Total to 437° F.	10+	2—	2—	1—
Total to 600° F.	20+	10–20	8–20	16—
Total to 680° F.	35—	27—	25—	25—
Tests on Residue from Distillation:				
Penetration 77° F., 100 g., 5 sec.	70–110	100–300	100–300	100–300
Ductility at 77° F.	60+	60+	60+	60+
Per cent soluble in carbon tetrachloride	99+	99+	99+	99+

—Not more than. +Not less than.

TABLE II—GRADATION SPECIFICATIONS OF STONE USED ON TEST SECTIONS

Designation	Use	Per cent retained on standard square mesh sieves: 2″	1½″	1″	¾″	⅜″	4	8
Number 3	Road mix	0	0–5	..	60–80	....	95–100	100
Number 7	Keystone	.. ..	..	0	0– 5	40–60	75– 90	100

Test Section No. 1.—The existing mat surface was not disturbed on this section. Number 3 stone was uniformly windrowed on the road and split into two equal parts, each part treated with approximately 8 per cent quick-setting emulsified asphalt and road mixed until all rock was thoroughly coated. This work was started late in the fall of 1934 and had to be discontinued because of cold weather. Before all of the material was mixed, a sudden cold wave stopped all operations and as the cold weather continued, the material was bladed into a windrow and no additional work was done on this section until spring. Upon resuming work in 1935, tests proved that the asphaltic content was too low and 1.7 per cent of MC 2 cutback asphalt was added, the material remixed, spread and rolled with a pull-type roller having a compression of 100 lb. per lineal inch of roll. A surface treatment of 0.1 gal. of MC 2 cutback per square yard was then applied, and keystone was spread on the surface at the rate of 30 tons a mile, and rolled until thoroughly compacted. The compacted material formed a mat 2½ in. thick.

Test Section No. 2.—Crusher run limestone was windrowed on this section at a rate of 600 tons a mile, treated with eight per cent emulsified asphalt and road mixed. Additional crusher run material was later added to bring the total to 1,200 tons a mile, and the asphalt content was increased to 4.5 per cent by the addition of MC 2 cutback asphalt. All of the material was then road-mixed, spread on the existing mat, and rolled. Keystone was not used on this section.

Test Section No. 3.—Number 3 stone was spread on this section at the 1,200 ton a mile rate; 4.65 per cent of MC 3 cutback asphalt was added and road mixed. The mat was then spread uniformly and rolled. A surface coat of 0.1 gal. a square yard of MC 3 was applied. No key material was used and the previous mat surface was not disturbed.

Test Section No. 4.—Crusher run limestone was distributed on the existing mat, 4.78 per cent of MC 4 cutback asphalt was added and the material road mixed. About 50 per cent of the material was treated and mixed at one time. When all of the stone was coated, the mat was spread and rolled. No keystone was used.

Test Section No. 5.—Because the surface of the old mat on this section was rough and had to be shaped, the whole road was scarified to a depth of 8 in. The broken mat and loose subgrade soil was then mixed with blades until the mat was pulverized so that no

Section 3: Rolling the Material After Part of It Was Spread on the Road.

pieces were larger than ¾ in. in diameter. This material was relaid in 2 in. lifts and each lift rolled with a pull-type roller. Due to the moisture in the clay subgrade, this operation was easily accomplished, and by the addition of sand and bituminous material from the old mat, the subgrade soil was stabilized to some extent. No. 3 stone was then windrowed on the subgrade, treated with 5.14 per cent of MC 4 cutback asphalt, road mixed and spread. The surface was rolled but not keyed, and was given a treatment of MC 4 cutback asphalt, applied at the rate of 0.1 gal. a square yard.

Test Section No. 6.—The subgrade on this section was given the same treatment as Section No. 5, and number 3 stone was again used. The main point of difference was that 4.45 per cent of MC 2 cutback asphalt was used instead of MC 4, and the edges of this section were trenched 2 in. deep and feathered out toward the center line of the road in 2 ft.

Test Section No. 7.—The subgrade on this section was also scarified, mixed, and rolled as in Sections No. 5 and No. 6. Number 3 stone was used and 4.3 per cent of MC 3 cutback asphalt added and road mixed. The mat was then uniformly spread and rolled. Surface treatment of 0.1 gal. of MC 3 cutback asphalt was applied, keystone was spread on the surface and the road again rolled.

The mat on all sections was spread to a width of 24 ft. and when compacted, formed a surface of from 2¼ to 2½ in. in thickness. After the mat was completed, the back slopes and ditches were trimmed and rolled and earth shoulders were built to the level of the mat and compacted by rolling.

The experimental road in north central Kansas was of similar construction and included additional variations in the types of cutback asphalt used. All sections of this road were constructed of crusher run limestone

After Placing All the Material But Before Keying. Section 3 in the Background

Completed Surface After Keying. This Is a View of Section 1.

which was distributed uniformly at the rate of 1,200 tons a mile. The existing base was of limestone gravel which had been penetrated with asphaltic road oil about one year previously.

An attempt was made to eliminate the mixing on one test section of this road. Half of the rock was spread over the full width of the road and penetrated with 1.25 gal. of RC 2 cutback asphalt per square yard. The remainder of the rock was spread over the road with blades and given the same treatment. However, this method failed to coat all of the rock and the cutback did not penetrate to the bottom of either layer.

This section proved to be unsatisfactory under traffic. The surface soon started to ravel, and had to be given a seal treatment of MC 2 cutback and cover stone.

The third experimental road included additional variations in gradation of material and types of asphalt and subgrade construction, the most noteworthy of which was the use of chat, both screened and mine run.

Conclusions.—The construction of the experimental sections brought out several interesting features. By scarifying the old mat and subgrade, it was found that this material could be readily mixed, due to the presence of moisture in the underlying subgrade. This procedure also affords an opportunity to reshape the roadbed and remove any existing irregularities.

Mixing the old mat with clay subgrade soil partially stabilizes the sub-base and will help remedy the soft, saturated condition that previously existed.

The open type surface further helps rectify this condition and, so far, has shown no tendency to push, rut or ravel.

No appreciable difference in the results can be noticed to date between crusher run and Number 3 stone, but if the stone contains more than ten per cent fines passing the eight mesh sieve, it is very difficult to coat with asphalt and spread uniformly.

A 6 in. crushed or sledged stone base should be laid over very unstable subgrade areas and rock ledge outcrops to provide better drainage and additional support.

A road or plant mix method is more satisfactory than a penetration method. No definite conclusion has been drawn as to the relative merits of different types of asphalt, except that variations should be made to suit the weather conditions that prevail at the time of year the work is done.

An excess of asphalt in the mat should be avoided. If there is a slight deficiency in asphalt, this condition can be remedied by the application of additional asphalt after the mat has been spread and rolled. However, if there is an excess of asphalt present in the mat, the only satisfactory remedy is to tear up the road, add additional material, remix and re-lay.

These experimental roads have been used by traffic only a short time, and no definite estimate as to the life and defects of this type of mat can be made. Because this type of surface can be built of aggregates that are produced at the roadside, the man-hour cost of construction is low. Test results so far have been satisfactory for a road of this type, and the Kansas Highway Commission has authorized the construction of 128 miles of coarse aggregate mat surfacing which will be built with WPH Funds in the near future.

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STATE HIGHWAY OFFICIALS TO MEET IN FLORIDA.—The 21st annual meeting of the American Association of State Highway Officials will be held Dec. 9-12 at Miami, Fla. W. C. Markham, 1220 National Press Bldg., Washington, D. C., is executive secretary.

Showing Operation of "Mule" on Gutter

"Mule" for Forming Curb

A novel method of forming curb and gutter on a concrete road was used on Section 40-15d of the Harlem Road in Winnebago County, Ill., near Rockford.

A "mule" was built of 2 x 6 lumber, the bottom shaped to form the desired profile of the curb. Strap iron runners were mortised in at the sides to ride on the pavement slab and the outer curb form. Boards on the top provide a platform on which four men rode to hold the "mule" tight to the pavement surface.

The "mule" was pulled by a cable attached to a truck by an angle iron extending far enough from the truck to give a direct pull and still allow the truck wheel to be safely away from the curb.

Concrete for about 100 ft. of curb was placed, after which the "mule" was pulled along to shape the concrete. The device was pulled at a speed of about 3 miles per hour, workmen with shovels and trowels filling in and clearing away concrete as required.

Only a small amount of hand finishing was required to complete the curb, hand floats and edging tools finishing the operation.

A. R. Carter is county superintendent of highways.

Showing Condition of Gutter After "Mule" Has Passed; Also Further Finishing by Hand

Placing the Last Lane of Concrete on a Section of the New Relief Highway Into St. Louis.

THE 3½-MILE EXPRESS HIGHWAY IN ST. LOUIS, MO.

UNSCRAMBLING motor traffic in metropolitan areas—providing adequate thoroughfares for modern speeds and numbers of vehicles—is a current task faced by road builders.

The volume and weight of city traffic and the high development of the areas through which improvement must be made result in an engineering and construction problem of no mean scope.

Among American cities, St. Louis stands near the top of the list in carrying out a successful attack on this problem. The latest link in the program, now well advanced, is an express highway that leads right into the center of St. Louis, with scarcely a ground-level intersection with other roads and streets throughout its 38 miles of multiple lane width.

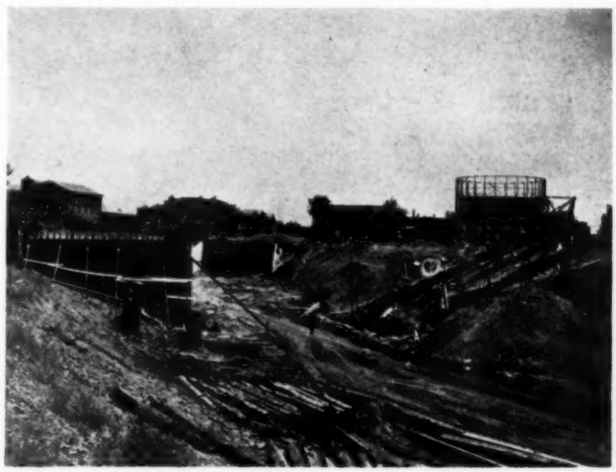
Westward from the Mississippi, the heaviest travel out of St. Louis is toward Kansas City, long served by U. S. 40, though generous volumes of traffic flow to and from St. Louis in all directions.

Belt Line First Step.—The first step in solving its traffic problem was to plan a belt line road skirting the city, to eliminate all unnecessary cross-town traffic. This belt line highway, Missouri 77, is nearly all three or four traffic lanes wide and circles the city five miles out beyond the city limits.

When the new express way is completed, motorists approaching on any Missouri highway may switch to the belt line road, follow it to the intersection with the express way, and quickly and safely continue into the heart of the city without the slow, tiring journey over rough, narrow and congested streets, built for an earlier generation, as must be done today.

Express Highway, 3½ Miles Long Within City.—Three and one-half miles of the express highway will be within the city, the eastern terminus connecting with broad streets leading to the nearby downtown business section or to the Municipal Bridge over the Mississippi. And one mile of the express way will be depressed, with all cross streets carried overhead.

The construction schedule has been such that work can continue through the winter and make it possible to open the completed project to traffic in 1936. Anticipating this, heating provisions for concrete work were made in the bridge contract. The cold weather work to be continued through the winter, except during the extremely cold weather, will include excavation and grading for the depressed section and construction of



Start of Depressed Section of Highway

Entrance to a Pedestrian Underpass

overhead street crossings. The remaining uncompleted slab will then be placed as soon as frost is out of the subgrade in the spring.

The new express highway, known as Traffic Relief 40, or T. R. 40, technically is a relief road to the west for U. S. 40 and U. S. 61. However, its usefulness will extend far beyond that. The city section of the highway is an NRM project, while the balance is being built with Federal Aid, all under the supervision of the state highway department, of which T. H. Cutler is chief engineer.

Five-Lane Highway in City.—The 3½-mile length within the city will be of five-lane concrete. The center lane, set off with white concrete markers, will be used for city-bound traffic during morning rush hours and for outbound traffic during the evening.

Two miles of the right-of-way lies along the south edge of Forest Park. Through the park the highway will be at ground level because of the terrain and the fact that cross traffic is no particular problem. At the eastern end of Forest Park, where the built-upcity begins, the real problem is encountered. Here, busy streets run north and south. The only satisfactory solution was construction of either an elevated or a depressed highway. Topography of the country and local conditions dictated the depressed highway.

One Mile of Highway to Be Depressed.—So for a mile the express highway will be sunken—cross traffic will speed overhead on street-level overpasses. The right-of-way width of half a block makes it feasible to gently slope the banks of the open cut, which will be sodded and landscaped. The depressed section will have an average depth of about 15 ft., with greatest depth at cross streets, but the roadway will rise slightly between streets to reduce construction costs.

The entire mileage within the city limits will not have a single ground-level intersection, inasmuch as ten highway overpasses and underpasses, four special pedestrian overpasses, or subways and one equestrian underpass will be built.

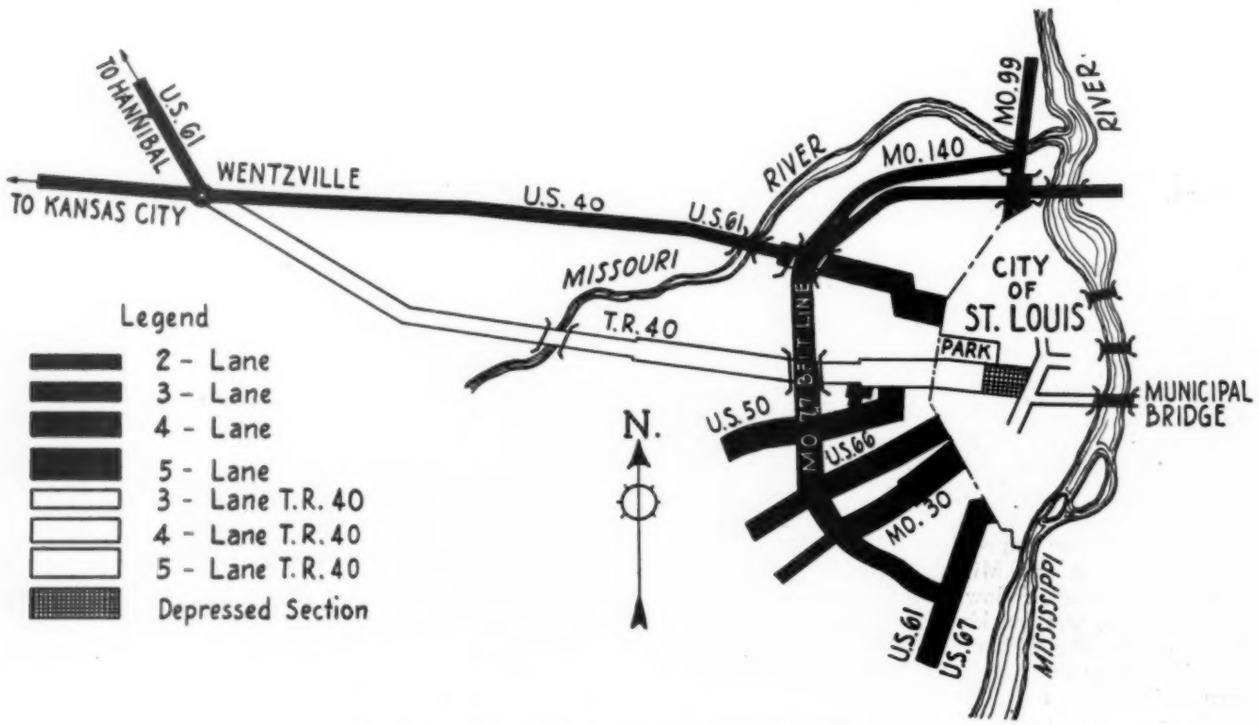
Moreover, two of the highway overpasses will be so constructed as to give entrance to the city section of the artery without hindrance to traffic. Six of the street overpasses will be of rigid frame concrete.

An interesting feature of the rigid frame construction is that in some cases these overpasses are being built half at a time, thus making it unnecessary to detour traffic.

The long stretch of T. R. 40 outside the city presents the problems usually attendant on new rights-of-way. From the city limits, for two miles the express way will be over existing Clayton Road, a 50 ft. pavement. Beyond Clayton Road, 13 miles of new concrete pavement four lanes wide will be built; from there on, six miles to the Missouri River will be three lanes wide.

A new bridge will be built over the Missouri. From there the road will continue 3 lanes wide for more than 13 miles, all over new right-of-way.

At Wentzville the relief road ends, joining with U. S.



Map Showing New Relief Highway and Its Connections.

Chutes Transporting Concrete from Paver to Bridge Foundations

40 proper and U. S. 61. Here, U. S. 40 continues to Kansas City and the west, while U. S. 61 goes to Hannibal, Keokuk and points north.

All in all, the express highway is an excellent example of what American cities can do to make access to downtown sections easy, comfortable and safe.

Securing Right of Way Through City.—Obtaining right-of-way through the city was a major problem, and it was handled in a business-like fashion. Along the edge of Forest Park, no difficulty was experienced, as this land was originally intended for a drive when the park was laid out. But the mile of depressed highway is being cut through what was once private property. Instead of following the usual procedure of obtaining this right-of-way by condemnation proceedings, the city appointed a representative who went into the field and purchased the property direct from the owners.

This method was found very successful, inasmuch as the city acquired nearly every parcel involved at a cost considerably lower than was anticipated. It was only necessary to condemn one or two pieces of property and these were obtained at a reasonable figure since the price precedent had been set. The right-of-way cost is estimated at about $765,000 to be paid by the city.

This Separation Was Built Half at a Time to Avoid Traffic Detours

The total cost of the entire project, including the three-lane road leading to Wentzville, is estimated at $4,850,000. But St. Louis figures the money well spent, since the city is getting a lasting, modern, entranceway that will provide for a flow of traffic at least twice that of an ordinary boulevard. This in turn will relieve congestion on many of the present crowded streets.

In fee simple, this express highway, now in the building, looks to the day when all sizeable cities will be equipped with traffic facilities actually fitted to the modern automobile.

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Determining Quality of Road Building Limerock

The less consolidated grades of limestone known locally as "Limerocks," because of their availability, are used extensively in the construction of road surfaces and base courses in the Southeastern states. A report on a study of these limerocks is given in the October issues of Public Roads by R. C. Thoreen, Assistant Highway Engineer, U. S. Bureau of Public Roads. The conclusions based on tests are stated as follows:

The test results indicate that the tests of greatest value for predetermining the quality of road-building limerocks are the plasticity, the field moisture equivalent, and the flocculation tests. While present information does not warrant the establishment of rigid limiting values, a plasticity index of 0 to the exclusion of all other determinations appears sufficient to indicate those limerocks that are likely to perform satisfactorily as base-course material under practically all conditions; a plasticity index from 1 to 7 and a field moisture equivalent not exceeding 20 indicate limerocks that will perform satisfactorily in carefully constructed base courses under average conditions; a plasticity index from 1 to 7 and a field moisture equivalent greater than 20 indicate limerocks that will perform satisfactorily in carefully constructed base courses under fairly dry conditions; and a plasticity index of 8 or more indicates lime rocks that are likely to prove troublesome.

Use of the foregoing tests does not eliminate desirability of using the chemical analysis in certain cases, such as those in which the quality of material within a given deposit or formation has been found to vary with the calcium carbonate content.

The flocculation test seems of sufficient significance to be useful for the preliminary field examination of limerocks. A flocculation factor exceeding about 1.9 will indicate material unsuitable for base-course construction, thus eliminating the necessity for any further tests. Of course a flocculation factor under 1.9 will not necessarily indicate a satisfactory material and must be supplemented by plasticity and field moisture equivalent tests for more definite identification. Use of the flocculation test in the field, however, will in some cases eliminate the inconvenience of sampling and transporting materials to a laboratory for further testing.

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45,000 Communities Without Railroad Service.—Interstate Commerce Commission records show 45,000 communities in the United States without railroad service. They, and those who fill their needs, depend upon the highways.

THE RIP VAN WINKLE BRIDGE

(Catskill-Hudson Bridge)

By A. B. GREENLEAF

Field Editor Roads and Streets

THE Rip Van Winkle Bridge, opened July 2, 1935, across the Hudson River between Catskill and Hudson, New York, is owned by the New York State Bridge Authority, and is one of the longest and most interesting bridges completed in 1935. The east approach is located in the town of Greendale, County of Columbia, and the west approach in the town of Catskill, County of Greene. The contract price was $2,164,894.70.

Principal Dimensions.—This bridge connects State Highway 8341 at the east and State Highway 5366 at the west. It is 5,040.17 ft. in length, and is comprised of a through truss cantilever structure 1,600 ft. long, 10 cantilever truss deck spans, and two plate girder spans. The span lengths measured between centers of bearing, beginning at the westernly end are:

Main cantilever anchor arm (west)	400 ft. 0 in.
Main channel span (2-200 ft. cantilever arms and a 400 ft. suspended span)	800 ft. 0 in.
Main cantilever anchor arm (east)	400 ft. 0 in.
9 330 ft. cantilever truss spans	2970 ft. 0 in.
1 cantilever truss span	247 ft. 6 in.
2 deck plate girders, spans 76 ft. 6 in. each	153 ft. 0 in.

The centers of bearing of the superstructure coincide with the center lines of the piers except at Pier 3, where there is a space of 5 ft. 6 in. between bearing centers of the through truss cantilever arm and the first of the deck spans, and at the plate girder end, where there is a space of 1 ft. 9 in. These spaces plus the lengths of the abutments equal 69.67 ft., which added to the span lengths makes up the total of 5,040.17 ft.

The main opening for the navigable portion of the river has a clear width of 765 ft. between piers, and a vertical clearance of 142 ft. above mean high water.

The through trusses are spaced 38 ft. 9 in. center to center, the deck trusses and plate girders 23 ft. 4 in.

Pier Towers.—All the piers except the last two at the easterly end are surmounted by steel towers carrying the superstructure. At Piers 1 and 2, supporting

Rip Van Winkle Bridge from the Air Before Completion of Deck Surface—Looking East.

the main cantilever portion, the towers are 121 ft. 1 in. high above top of masonry, with base dimensions of 20 ft. 3¾ in. by 58 ft. 11 in. At Pier 3, where the through truss and deck truss portions meet, the height is 118 ft. 6 in. Approach bents have a standard height of 70 ft. 10½ in. and a base 11 ft. ¾ in. by 41 ft. ¾ in.

Foundations.—The west abutment and Piers 1, 5, 6 and 12 rest on solid rock, Piers 2, 13, 14 and the east abutment rest on hardpan. The remainder of the piers are supported on pipe piles driven to rock. The tubes are seamless, medium carbon steel, and conform to the requirements of the standard specification for welded and seamless steel pipe of the American Society for Testing Materials. They have an outside diameter of 14 in. and thicknesses of 5/16 in. and ⅜ in. Not more than one splice is used in the total length of any pipe pile. The piles, before being driven, were equipped with an approved shoe. After driving, the tubes were inspected for defects and alignment, water was removed from the inside, and concrete placed therein. The original contract provide for the use of cast-in-place concrete piles at Piers, 4, 7, 8, 9, 10 and 11, but the contractor elected to use 14 in. pipe piles with 5/16 in. shells in lieu of them. The estimated load on each ⅜ in. shell pipe pile is 40 tons.

Erection of Channel Span.—The superstructure for the 800 ft. channel span was erected in the usual manner, that is, by the cantilever method working both ends toward the center. The two parts of the suspended span were erected to a slightly raised position and lowered by means of jacking devices at top and bottom chords of the cantilever arms. No difficulty was encountered in matching the rivet holes at the center of the span when its two parts were lowered by the jacks.

Pavement and Sidewalk.—The width of the vehicular pavement between curbs is exactly 30 ft. It consists of a concrete slab having a concrete wearing surface 1½ in. thick monolithic with the slab. A sidewalk on one side only is 4 ft. 5½ in. wide. Between the sidewalk, which is on the downstream side, and the pavement there is a 6 in. curb. There is a metal railing on each side of the bridge for its entire length. It is interesting to note that about 250 ft. of roadway deck was poured each day. On Friday, May 24, 1935, the contractor poured 322 ft. 9 in. Concrete for the decks of the 800 ft. span was pumped 1,200 ft. with a Rex pump.

Loadings.—The bridge was designed for a dead load of 4,720 lb. per ft. in addition to the actual weight of steel. This load was made up of the following items:

Concrete roadway slabs and reinforcing	3570 lb.
Future paving	750 lb.
Excess	400 lb.

Live loads were assumed as follows:

For each traffic lane of the roadway, concentrated loads of 24,000 lb. and 88,000 lb. spaced 14 ft. apart, or

a uniform load of 1,280 lb. per lin. ft. plus concentrated loads of 60,000 lb. for moments and 80,000 lb. for shears.

For entire roadway (3 lanes).

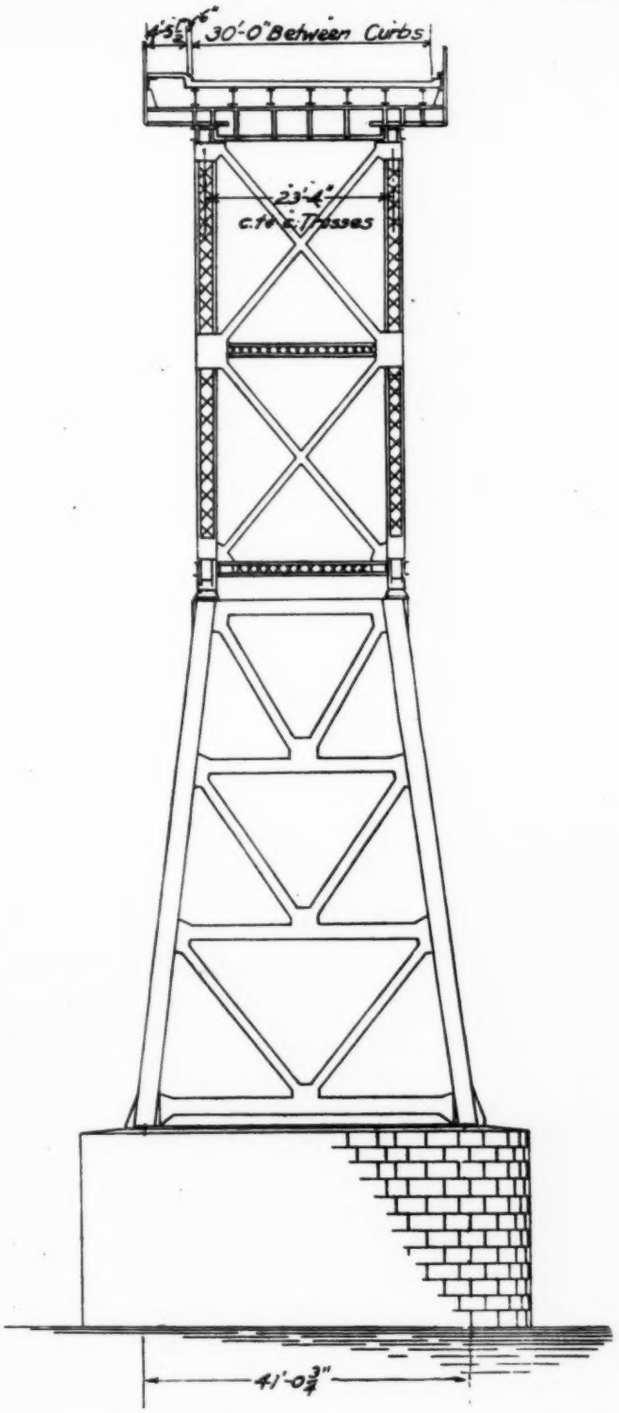
$3 \times 90\% = 2.7$ lane loads.

For heavy truss, a uniform load of 2,000 lb. per lin. ft. plus concentrated loads of 90,000 lb. for moments and 120,000 lb. for shears.

For sidewalk, uniform loads of 200 lb. per sq. ft. for local members and 100 per sq. ft. for trusses, etc.

Allowance for impact is included in the foregoing live loads.

Basic design stresses were 24,000 lb. per sq. in. on carbon steel and 32,000 lb. on silicon steel.



An Approach Bent and Section Through One of the 300 Ft. Cantilever Trusses.

Wind load was taken as 50 lb. per sq. ft. on 1½ times the exposed area of trusses and floor system. Erection wind load was 30 lb. per sq. ft. on 1½ times the exposed area of steel work and erection equipment. Erection load consisted of 70 ton travelers plus 15 per cent impact. Assumed weight of staging and track was 500 lb. per lin. ft. of bridge.

Price Details.—The $2,164,894.70 contract price of the structure included clearing the site; east and west approaches and miscellaneous structures; administration and toll booths, and the electric lighting equipment for

roadway, administration building, and navigation purposes.

Following are the details:

Items	Amount Bid
Necessary clearing and grubbing	$ 3,300.00
141,000 cu. yds. unclassified excavation (except as provided for in other items)	105,750.00
9,000 cu. yds. unclassified excavation for piers 1, 3, 4, 7, 8, 9, 10, 11 and 12	14,850.00
7,200 cu. yds. unclassified for Pier 2	33,408.00
6,300 linear feet trimming shoulders	315.00
18,100 sq. yds. preparing fine grade	1,448.00
500 linear feet sewer pipe, 6-in. diam.	130.00
156 linear feet sewer pipe, 18-in. diam.	187.20
4,700 linear feet pipe underdrain, 4-in. diam.	705.00
400 linear feet pipe underdrain, 6-in. diam.	88.00
652 linear feet reinforced concrete pipe, 18-in. diam.	1,010.60
64 linear feet reinforced concrete pipe, 24-in. diam.	131.20
172 linear feet reinforced concrete pipe, 36-in. diam.	619.20
55,600 bbls. portland cement	86,736.00
5,850 cu. yds. concrete for structures (1-2-3½)	52,650.00
383 cu. yds. first-class concrete (1-2-4)	3,255.50
7,400 cu. yds. second-class concrete (1-2½-5)	44,000.00
1,700 cu. yds. stone masonry	75,650.00
18,100 sq. yds. metal reinforcement for concrete pavement	3,077.00
2,950 sq. yds. steel fabric reinforcement for concrete sidewalk slabs	383.50
2,100 lbs. bar reinforcement for concrete pavement	84.00
210 sq. ft. metal reinforcement for culverts	21.00
649,000 lbs. bar reinforcement for structures	16,874.00
335,000 linear feet reinforcing trusses for roadway slabs	33,500.00
12,500,000 lbs. structural carbon steel	512,500.00
10,700,000 lbs. structural silicon steel	508,250.00
389,000 lbs. miscellaneous iron and steel	15,560.00
650 linear feet rustic timber guide railing	812.50
3,500 lin. ft. cable guide railing	2,450.00
55 guide posts	110.00
10,000 linear feet metal railing	18,500.20
800 cu. yds. bottom course, run of bank gravel, loose measure	1,000.00
4,000 cu. yds. cement concrete pavement (1-1¼-3½)	16,000.00
Necessary protection of traffic	500.00
17,000 linear feet pipe piles, 14-in. diam.	46,750.00
27,000 linear feet cast-in-place concrete piles	54,000.00
6 loading tests for cast-in-place piles	9,900.50
1,550 cu. yds. foundation for Pier 1	22,087.50
9,400 cu. yds. foundation for Pier 2	310,200.00
1,900 cu. yds. foundation for Pier 3	28,500.00
620 cu. yds. foundation for Pier 4	11,160.00
3,300 cu. yds. foundation for Piers 7-12 inc.	69,300.00
500 linear feet borings	1,375.00
600 tons of 2,000 lbs. broken stone, loose measure	900.00
260 cu. yds. concrete gutter	1,924.00
10 catch basins and manholes	780.00
80 concrete right-of-way markers	120.00
2 M ft. B. M. timber and lumber	150.00
Necessary electrical work	23,695.00
Necessary administration building and toll booths.	15,500.00
Necessary water mains and connections	6,160.00
Necessary top soil, seeding and transplanting	6,059.42
5 load tests for soils	1,000.00
270 sq. ft. reflector signs	945.00
Gross bid	$2,164,894.70

Toll Rates and Bond Retirement.—Toll rates established for the bridge are as follows:

SINGLE TRIP FARES

(All vehicle fares include driver)

Passenger automobile	$0.80
Extra passengers, $0.10, maximum fare $1.00.	
Trucks—Rated Capacity:	
2 tons or under	0.80
Over 2 tons, inc. 3 tons	1.00
Over 3 tons, inc. 5 tons (15 tons gross)	1.50
Passenger car trailer	0.20
Motorcycle, $0.20; with sidecar	0.35
Franchise buses, $0.20; irregular busses	0.80
One-horse wagons, $0.25; two-horse wagons	0.35
Pedestrians or bicycles, each	0.10

COMMUTATION BOOKS

(Valid for period stated from date of issue)

	Period	
Passenger cars:		
10 trips Good for 1 passenger car or 1 light delivery car under 1 ton.	6 months	$ 3.50
25 trips Good for one or more passenger cars owned by same individual or firm.	50 days	7.50
62 trips Good only for individual car to which issued.	52 days	12.00
50 trips Good for 2 passenger cars or 2 light delivery cars under 1 ton, owned by same individual or firm.	1 year	15.00
Trucks: Rated Capacity	Period	
25 trips 2 tons or under	6 months	$12.50
50 trips over 2 tons, inc. 3 tons	1 year	37.50
50 trips over 3 tons, inc. 15 tons	1 year	50.00

Gross loads exceeding 15 tons allowed to cross only by special permission.

Commutation rates available for conventions, funerals, etc., on application to bridge superintendent 24 hours in advance.

It is estimated that traffic will be sufficient to retire the bonds in 20 years. A law passed by the New York legislature, however, provides that tolls collected at the Mid-Hudson Poughkeepsie bridge may be applied to the liquidation of the bonds for the Rip Van Winkle bridge.

This bridge is not a replacement of an existing bridge. It is a new bridge at a new location. There were no problems of river control or maintenance of river traffic during its construction.

Bridge Authorities and Contractors.—This bridge was constructed under the supervision of the New York State Bridge Authority, Colonel F. S. Greene, Chief Engineer, H. O. Schermerhorn, Deputy Chief Engineer. The services of the New York State Department of Public Works were utilized, R. B. Smith, Resident Engineer, O. Hasbrouck, Supervising Engineer. The General Contractor was the Frederick Snare Corporation. Subcontractors for structurel steel and the concrete deck were awarded respectively to Harris Structural Steel Co. and Corbetta Construction Co. Original plans were prepared by Glenn B. Woodruff, Consulting Engineer, whose services were terminated by his own request on May 11, 1932. Plans, specifications and estimates were later revised by the New York State Department of Public Works.

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More Exhibit Space Required for Road Show

Demands for exhibit space at the 1936 Road Show have made it necessary for the American Road Builders' Association to provide additional display area.

The A. R. B. A. Joint Exhibit Committee met in Cleveland Oct. 24 to allot space for the Road Show, but when applications already received were totaled it was found that space requirements exceeded the area engaged for the Road Show. This resulted in postponement of the first allocations date until Nov. 13, and the immediate engagement of the Arcade and the North Hall to supplement the New Exhibition Hall for the 1936 Road Show in Cleveland, Jan. 20-24.

This combined space is one spacious exhibition area, the Arcade being the broad connecting "avenue" between the North Hall and the New Exhibition Hall.

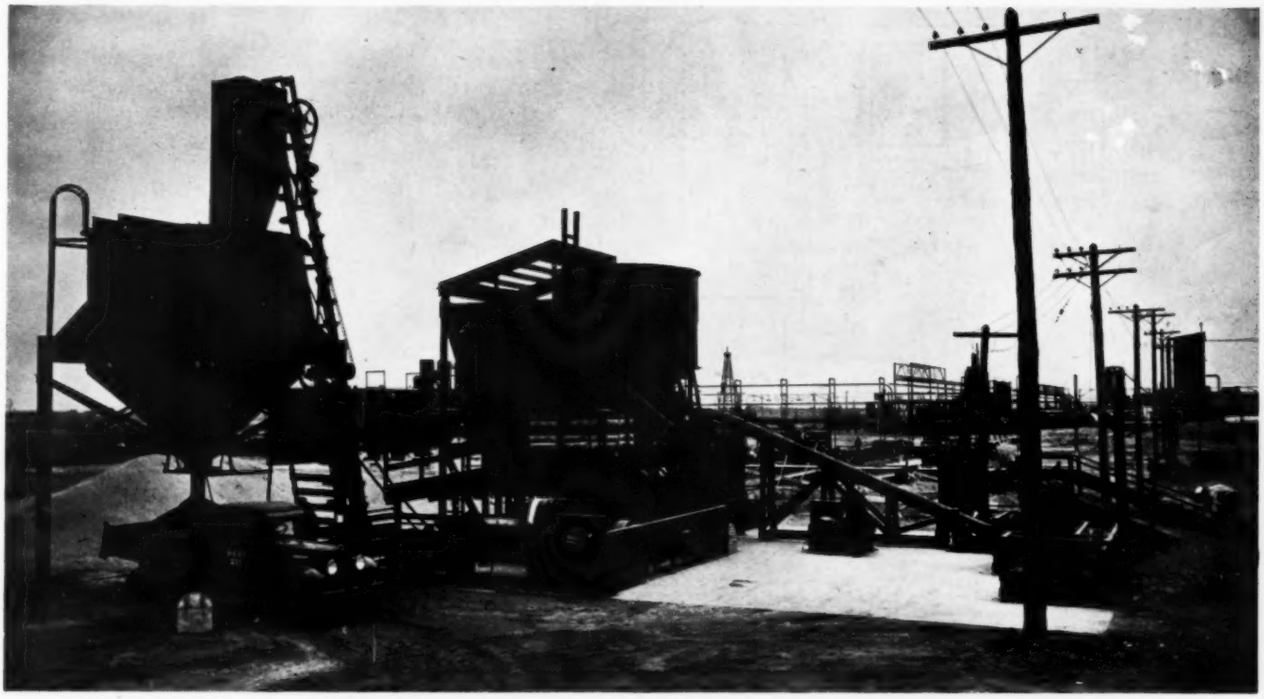

Fig. 2—View of Plant for Producing Stabilized Road Material.

PLANT MIXING OF STABILIZED SOIL ROAD-SURFACING MATERIALS

By L. C. STEWART and S. J. WHITE

Road Stabilization Department, The Dow Chemical Company, Midland, Mich.

ROAD engineers recognize the service and economic advantages of gravel, stone or slag wearing courses stabilized with calcium chloride and natural binder-soil. The technique of building these roads in place has improved continuously through several seasons. For some time, however, there has been a growing demand for a centralized pre-mixing plant that would combine the proper materials in the desired proportions to produce a stabilized mixture that could be delivered and immediately compacted on the road. In August of 1934 the Road Stabilization Department of The Dow Chemical Company started a study of the matter which led to the development and construction of the plants described in this article.

Advantages of Central Plant.—Operation of a central plant for stabilizing road surfacing aggregate appeals to both road engineers and producers of gravel, stone and slag. From the road engineer's standpoint, the advantages are as follows:

1. The use of expensive equipment is eliminated. Maintenance machinery is not tied up on construction work when it may be needed for the chief purposes for which it was purchased.

2. Dust nuisance and traffic annoyance incident to operations on the road are eliminated. The damp mix as delivered to the job, packs immediately under traffic or by rolling.

3. More accurate control of the properties of the wearing course and more thorough mixing are provided than can be obtained when the materials are mixed on the road.

4. Costly delays due to waiting for materials to dry after periods of wet weather, are eliminated.

5. The season during which stabilized roads may be built, is extended to include practically the entire year.

6. Stabilized gravel road surfaces may be obtained by towns and villages which do not own equipment suitable for performing the necessary construction operations on the road. Hence, plant stabilized material makes it simple and inexpensive to obtain this desirable type of road which otherwise might not be available to them.

Should Appeal to Aggregate Producers.—Plant stabilization of road materials is attractive to aggregate producers since many of them have excessive accumulations of small size aggregate which when combined with calcium chloride and locally available sand, silt and clay, will give a wearing course composition of satisfactory grading and soil properties. Also, gravel producers frequently have an overburden of silt, clay and sand mixtures which has heretofore been thrown away or has become an eyesore due to accumulation. By subjecting such excess materials to soil tests, it is frequently possible to determine combinations of them which can be used to advantage and profit in producing stabilized wearing course mixes.

It is recognized that ownership and operation of central stabilizing plants by cities, counties or even states.

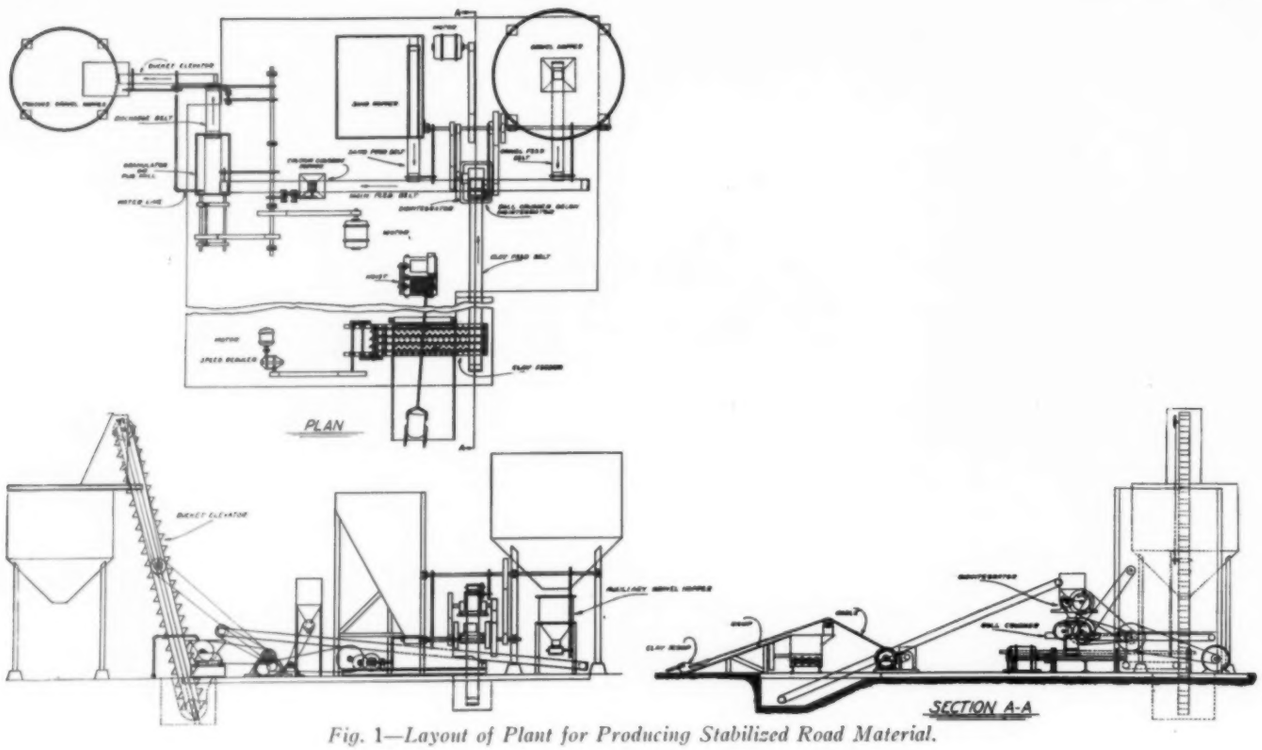

Fig. 1—Layout of Plant for Producing Stabilized Road Material.

would frequently involve construction of smaller units than if they were built by large producers of aggregates. In fact small portable plants probably would be desirable in many cases where public ownership is involved. It was decided, therefore, to construct a demonstration plant which would furnish the general information which might logically be desired in both types of plants. In all cases the details of design and operation of such units would be governed by local conditions as to properties, costs and availability of the necessary materials.

Composition of Wearing Courses.—Specifications of the Calcium Chloride Association adopted January, 1935, state the following, concerning the composition of wearing courses stabilized with calcium chloride and binder-soil:

"The final mixture of graded aggregate and binder-soil shall be so graded—and combined in such proportions as to produce a mixture conforming to the following composition limits by weight:

Passing 1-inch sieve*.....	100 per cent**
Passing ¾-inch sieve.....80-100	per cent
Passing ⅜-inch sieve.....50-100	per cent
Passing No. 4 sieve.....40- 80	per cent
Passing No. 10 sieve.....30- 60	per cent
Passing No. 40 sieve.....20- 45	per cent
Passing No. 270 sieve***.....10- 25	per cent

"The fraction passing the No. 270 sieve shall not be more than two-thirds of the fraction passing the No. 40 sieve.

"The fraction passing the No. 40 sieve shall have a plasticity index between 6 and 14.**** The liquid limit of this fraction shall not exceed 35 per cent, as higher values indicate the presence of the undesirable micaceous, diatomaceous and peaty substances productive of sponginess and high capillarity. These test values shall be determined by the physical test methods of the U. S. Bureau of Public Roads. (Described in Public Roads, Vol. 12, No. 8, October, 1931.)

"In case that all or part of the Graded Aggregate consists of slag there shall be a correction made in the gradation of the final mixture, depending upon the weight-volume of the materials used."

The above-mentioned specifications also provide that calcium chloride shall be uniformly incorporated in the final mixture of road materials at the rate of ½ lb. per square yard, per inch of thickness of road. This is equivalent to about 10 lbs. of calcium chloride per ton of stabilized material.

Raw Materials.—In combining the aggregate and binder-soil to produce a mixture conforming with the specifications, a wide range of raw materials may be used. Thus, if a sand-clay over-burden is available, the coarse aggregate will be in the nature of non-sandy pea gravel or equivalent stone or slag. On the other hand, if it is desired to use a sandy, pit-run gravel or other

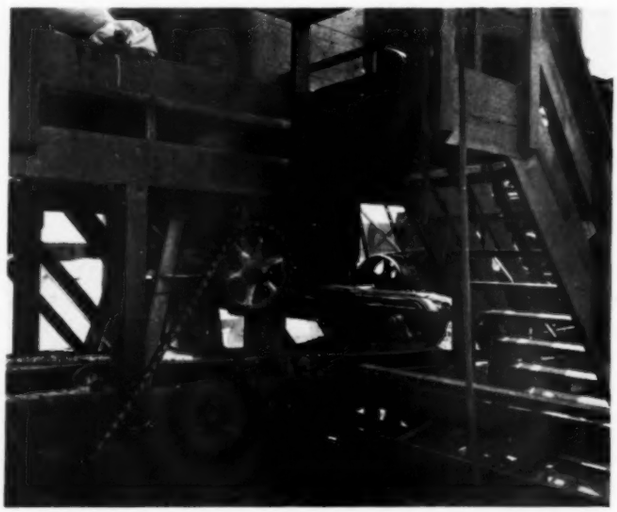

Fig. 3—Close-up View of Sand and Calcium Chloride Feeds.

***Standard settling rate test ordinarily used in the mechanical analysis eliminates the need of the No. 270 sieve.

****The higher ranges of plasticity index are desirable when the percentage of material passing the 40 mesh sieve is near the lower limit as provided in the above table, and the lower ranges are desirable when the percentage of material passing the 40 mesh sieve is near the upper limit in the gradation requirements.

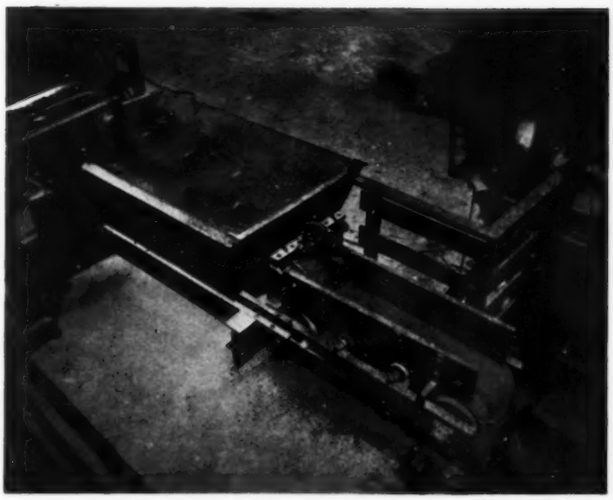

Fig. 4—Granulator Mixing Binder-Soil, Aggregates and Calcium Chloride

aggregate graded down to the No. 100 sieve, a sticky, plastic clay will be required. In general, it is believed that the best final product is one containing close to the lower limits of soil fines (material passing the No. 40 sieve), and approaching the higher limit of plasticity index.

For several months a demonstration plant, constructed by The Dow Chemical Company, has been producing a completely stabilized soil-bound road-surfacing mixture. The materials mostly used are pea gravel, sand, a mixture of clay and silt and Dowflake calcium chloride. Slag, however, has been used instead of pea gravel on some occasions. This plant, as constructed, will produce between 20 and 25 tons of stabilized material per hour. The pit from which the gravel is shipped is located about 75 miles from the plant. As received this material is either unloaded into a stock pile or into a large hopper. All slag was unloaded directly into the hopper. The clay-silt mixture and sand are conveniently located on the company's property.

There are two reasons for using a mixture of clay and silt. The first is that service tests have shown that the presence of some silt is desirable in a stabilized road surface. Second, most natural clays contain more silt than the one found locally, and hence to simulate conditions which are more likely to prevail in most localities, it is desirable to add some silt. The clay and silt are found in layers, the latter on top, and are dug in about equal quantities with a tractor-shovel and loaded into trucks and delivered to the plant where the mixture is stored in a large pile. The sand is loaded, delivered and stored in a separate pile in the same manner.

Sieve analyses and soil properties of the raw materials and of the final product are given in Table I.

Plant Design and Operation.—In a quite small preliminary plant for stabilizing road surfacing aggregates, the binder-soil, after being air-dried, was ground in a hammer mill. Considerable trouble was encountered in this operation unless the clay was bone dry. The various materials were fed from compartments of a large bin, into one end of a trough containing a ribbon screw conveyor which was supposed to mix them together and discharge the finished product at the other end. Water was added while mixing was in progress. What actually happened was that during the mixing process the conveyor built up a hard mat on the bottom and sides of the trough, causing a binding action to such an extent that it resulted in breaking of sprockets, chains and even the conveyor shaft.

About this time it was decided to visit the plants of a number of manufacturers of clay-handling machinery as well as the plants of several producers of clay brick and tile. As a result of conferences and observations at such plants, it was concluded that in all probability the clay-drying step could be omitted by using disintegrators or roll crushers for preparing the binder-soil. It was also decided that a pug mill, or a granulator which is quite similar, would be a more satisfactory piece of equipment in which to accomplish the final mixing of the constituents of stabilized gravel.

Plant Equipment and Operation.—A layout of the plant as finally designed and operated is shown in Fig. 1, while a view of it may be seen in Fig. 2.

A large scoop scraper is filled with the clay-silt mixture as it is drawn through the stock pile by an electric hoist. After being pulled up an inclined ramp the load is dumped into a Brewer No. 123 spiral feeder. It is very rugged in construction and has a storage bin of large capacity, the measurements being 7 ft. long, 3 ft. 2 in. wide, and 3 ft. 6 in. deep. The material is carried to the discharge end of the hopper by four 9-in. diameter screw conveyors located in the bottom and running full length of the hopper. These conveyors are gear driven and so arranged that two rotate clock-wise and

Fig. 5—View of Road Resurfaced with Plant-Mixed Stabilized Gravel

TABLE I—ANALYSES OF RAW MATERIALS AND FINISHED PRODUCT

	Mechanical Analysis—Per Cent by Weight							Soil Tests—Per Cent Moisture			
	Pass ¾ in. On ⅜ in.	Pass ⅜ in. On No. 4	Pass No. 4 On No. 10	Pass No. 10 On No. 40	Pass No. 40 On No. 270	Silt	Clay	Liquid Limit	Plasticity Index	Shrinkage Limit	Field Moisture
Pea gravel	4	53	37	6							
Bank sand				18	82						
Silt				1	6	59	34	25	7	19	18
Clay				2	8	12	78	57	37	23	15
Stabilized wearing course material	3	38	26	8	15	4	6	20	10	13	10

Calcium chloride content of finished stabilized material averages 0.5 per cent, i. e., 10 lbs. per ton.

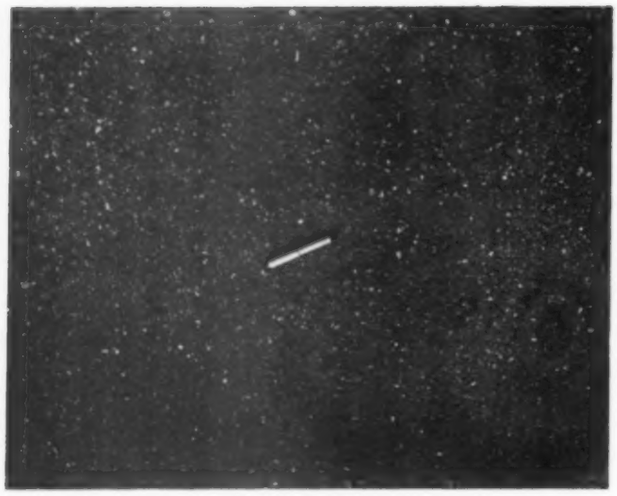

Fig. 6—Close-up View of Road Shown in Fig. 5.

two anti-clock-wise towards the center of the hopper. At the discharge end there is a regulating gate which can be set in any desired position. The mixture is discharged into a small hopper over an inclined belt conveyor that elevates it to a Freese No. 24 disintegrator.† This has a slow-speed roll 24 in. in diameter and a fast-speed roll of 12¾ in. in diameter with knives across the front of it that rotate in opposite directions. All large lumps are cut into small pieces as the mixture passes through the rolls to a Freese No. 9 crusher, constructed directly under the disintegrator and above the main conveyor belt. The rolls crush all stones up to 1 in. in diameter and throw out the larger ones.

The crusher has two low-speed smooth face rolls 18 in. in diameter that travel in opposite directions. In passing through these rolls the damp material is further reduced into flat flakes of approximately 1/16 in. thick, having an area varying from ¼ to 4 sq. in. Any dry material is completely pulverized when it comes through the rolls. There are adjustments on the disintegrator and crusher to vary the opening between rolls as desired. The discharge from the crusher falls onto the main conveyor belt to be delivered to the granulator, along with the sand, gravel and calcium chloride. All conveyor belts throughout the plant are standard 5-ply rubber-covered and 18 in. wide.

The gravel is elevated to a 112-ton capacity steel hopper by a railroad crane. From this it feeds into a 4-ton capacity auxiliary steel hopper located directly above a conveyor belt that carries the material to the main conveyor belt. The bottom of the auxiliary hopper sets quite close to, but not touching, the conveyor belt and has a control gate on the front end to regulate the flow of the gravel.

The sand is loaded into a 45-ton capacity rectangular wooden hopper by the railroad crane. One side of this hopper slopes at an angle of 60° while the other side and two ends are vertical. With such a design the wet sand does not stick up or bridge over. A number of horizontal sliding gates are constructed in the bottom of the hopper. All gates are closed during the filling operation. Starting at the front end they are opened, one at a time, as necessary to permit sand to flow onto a belt which extends the full length of the hopper and which carries the sand to the main conveyor belt. The control gate that regulates the rate of feed of the sand can be seen in Fig. 3.

A 1-ton capacity calcium chloride hopper with a feed control near the lower end, is built directly above the main conveyor belt and discharges onto it. This is shown in Fig. 3. The Dowflake calcium chloride is dumped into the hopper by hand from an elevated platform where a supply is kept on hand.

The gravel, sand, clay-silt mixture, and calcium chloride are delivered to a Freese No. P2 granulator. About 6 per cent of water is added at this point and all ingredients are thoroughly mixed together. Fig. 4 shows this operation. As the finished product is extruded from the granulator, it is delivered by a short conveyor belt to a bucket elevator that discharges into a steel storage hopper of 60 tons capacity. It is then loaded into trucks through the bottom of the hopper and hauled to the roads or put in a stock pile. Railroad shipments can also be made if desired.

Granulators of different capacities can be obtained but the steel one which was installed is 2 ft. deep, 7 ft. long and 4 ft. wide at the top. The sides are V-shape with a rounded bottom and both ends are vertical.

The shanks of the 24 replaceable, cutting and mixing blades are held tightly by keys in holes drilled through a steel shaft. The latter extends the full length of and through the ends of the granulator. Each end of the shaft is supported by external bearings.

The rate of discharge and consequently the amount of mixing the aggregates receive, is governed chiefly by the speed of the shaft and the pitch of the adjustable blades. The shaft is pulley-driven through a set of reducing gears.

The plant is operated by four electric motors of different sizes. Pulleys, sprockets and gears of the correct size are used in obtaining the desired speeds of the various units. The duties of each motor are described briefly as follows: A 25 h.p. 1150 r.p.m. motor is used to draw the scoop through the stock pile of the silt-clay mixture and up the inclined ramp to the spiral feeder. The latter is operated by a 7.5 h.p. 1150 r.p.m. motor. The disintegrator, crusher, and the sand, gravel and clay conveyors are operated by a 50 h.p. 675 r.p.m. motor. Other units consisting of the granulator, bucket elevator, discharge conveyor and calcium chloride feeder are driven by a 30 h.p. 690 r.p.m. motor. A combination of belt, chain and gear drives are used in operating the various units.

The present output of the plant is limited by the granulator which has a capacity of 20 to 25 tons per

Fig. 7—Preparation of Sand-Clay Overburden for Use in Stabilized Gravel.

†It is desired to acknowledge the kind cooperation of E. M. Freese & Co., of Galion, O., in supplying a disintegrator, roll crusher and granulator for use in the demonstration plant.

hour. This could easily be increased by the installation of a larger granulator or pug mill, as the rest of the plant is designed to produce 60 to 75 tons of stabilized material per hour.

Normally the clay-silt mixture has a moisture content of between 15 and 20 per cent when received from the pit. In dry weather this is reduced to between 12 and 15 per cent before it reaches the disintegrator and crusher. Heavy rains of several days' duration have a tendency to saturate the stock pile of the clay-silt mixture and make it more difficult to work. The delays of plant operation on this account are very few and could be eliminated entirely by building a shelter over the binder-soil stock pile.

There has been no difficulty in producing a finished product of uniform grading and desired plasticity index. A slight variation in the different shipments of pea gravel necessitates the occasional adjustment of the sand and binder-soil feed in order to maintain a constant mix. Table I gives the analyses of the raw materials and finished product.

A central mixing plant such as the one which has been described, may also be used for producing various types of soil-mixtures for special purposes. For example, in resurfacing a road which has a large quantity of floating cover, the loose material can be stabilized by combining it with a light application of plant mix having a relatively high binder-soil content before spreading the standard stabilized material. Also a crushed clay-silt mixture can be produced which is suitable for binding up sandy sub-grades as well as loose road surfaces. This material may be distributed very satisfactorily with a centrifugal spreader.

Figure 5 shows a view of a road resurfaced with plant-mixed stabilized gravel and Fig. 6 shows a close-up view of the same road.

The Cost of Production.—Production cost of plant stabilized material will vary considerably in different localities. The chief factors are the cost of the ingredients used and the proportions of each required to give the proper finished product. Binder-soil especially if available as overburden in a gravel pit, can be obtained more cheaply in some localities than in others. In some cases the grading of the aggregate and binder-soil is of such a nature that the addition of sand will not be necessary. For example, in Oakland County, Michigan, The Standard Gravel Co. has a pit with an overburden containing sand, silt and clay in proportions suitable to make an ideal binder-soil for stabilizing pea gravel. It has a plasticity index of 12 and breaks up quite easily as it is stripped from the top of the pit.

After the officials of The Standard Gravel Co. had examined the demonstration plant in Midland and had discussed the matter thoroughly, they decided to build a plant of somewhat modified construction. It appeared logical that binder-soil, obtained by screening the overburden through grizzly bars and a 1-in. vibrating screen, would intimately combine with pea gravel and calcium chloride in a pug mill to make a very satisfactory stabilized mix. This was found to be the case and thus it was possible to eliminate the spiral clay feeder, disintegrator and roll crusher, all of which greatly reduced the cost of construction. Figures 7 and 8 show the inexpensive equipment used at the plant of The Standard Gravel Company to produce about 40 tons of stabilized gravel per hour.

The usual proportions of materials used in the demonstration plant are: Gravel 70 per cent, sand 20 per cent and clay 10 per cent. Calcium chloride is added at the rate of 10 lbs. per ton of stabilized material. Based on an hourly production of 20 tons, the cost of

Fig. 8—Standard Gravel Company's Plant for Mixing Constituents of Stabilized Gravel

the finished mix is $1.25 per ton. As this rate is increased the cost of production will naturally decrease. The cost of making this material at the plant of an aggregate producer should be somewhat less as the cost of shipping the pea gravel 75 miles would be eliminated.

The cost per ton of producing the stabilized material in the demonstration plant is given in the following summary:

0.7 tons gravel at $1.00 per ton	$0.70
0.2 ton sand at $0.30 per ton	.06
0.1 ton clay at $0.35 per ton	.035
10 lb. calcium chloride at $19.00 per ton (in Michigan)	.095
Power	.15
Labor	.10
Maintenance, depreciation and miscellaneous	.11
Total, per ton	$1.25

Although the plant was built primarily to determine the best methods of preparing plant-mixed, stabilized soil road surfacing materials, it has been interesting to note the increasing local demand which has arisen for the product. As a consequence the plant has been operated steadily for more than five months and has produced over 10,000 tons of stabilized gravel. The results which have been obtained have shown that the process and the product possess all the advantages mentioned at the beginning of this article. The resulting surface mats of the roads constructed with the plant-mixed material are very dense, firm, dustless, and have exceptionally good wet weather properties.

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World Production of Automobiles

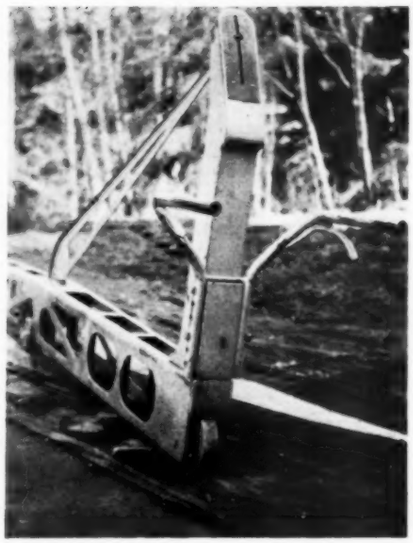
In 1930 the United States produced 81.3 per cent of all automobiles manufactured in that year. In 1934 this country produced 73.8 per cent. The following table from Automotive World News, a publication of the U. S. Bureau of Foreign and Domestic Commerce, shows the world motor vehicle production during the years 1930-1934:

Item	1930	1931	1932	1933	1934
World total	4,126,470	3,048,648	1,976,963	2,675,619	3,728,891
Increase (+) or decrease (—), per cent	—34.3	—26.1	—35.1	+35.3	+39.3
Production by (as pct. of total)—					
United States	81.3	78.4	69.3	71.7	73.8
Canada	3.7	2.7	3.1	2.5	3.2
Other countries	15.0	18.9	27.6	25.8	23.0
Total	100.0	100.0	100.0	100.0	100.0

Bituminous Paving Practice On Oregon State Highways

By N. M. FINKBINER

Engineer of Materials, Oregon State Highway Commission



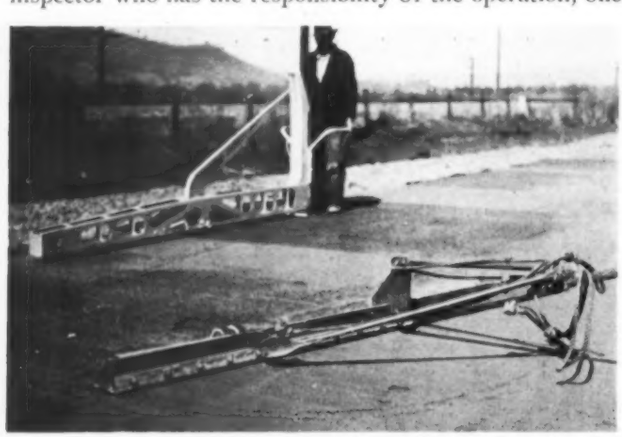
Operator's End of Planometer

ON NEW WORK Oregon lays a 3 in. tight bituminous base, the mix of which is somewhat similar to the top with some of the asphalt and filler removed. Upon this base is laid 2 in. of top mix designed for tight stability. Into this rolled top mix, while still warm, hot asphalt coated chips, ¾ in. to ¼ in., are spread at the rate of 8 to 12 lb. per square yard and rolled into the top to make the surface nonskid.

On resurface work the depressions in the old pavement are filled with a leveling course composed of asphalt and ¾ in. minus crushed stone. The sand grading of this mix is as carefully set as the sand grading in the wearing surface used in new work. "D" grade 51-60 penetration asphalt is the cementing medium used. Upon this leveled pavement we use a cutback asphalt wearing surface, a minimum of 1 in. thick which is graded from ¾ in. to dust and has RC-4 cut back asphalt as the binding medium.

Volume measure of aggregates at the paving plants is no longer permitted unless every truck load is weighed upon a properly checked and certified scale. Nor, is the use of drum type mixers allowed unless specifically permitted in the special provisions of the specifications. All bituminous mixes are purchased by the ton in place.

Inspection at Mixing Plant.—The number of state men at a contractor's paving plant depends on the tonnage produced. In general the crew consists of one plant inspector who has the responsibility of the operation, one screener, and one materials checker. The plant inspector has general supervision, watches temperatures of asphalt and the finished product, and keeps a weather eye on all material entering the cold stone elevator. The screener samples the bins at regular intervals, screens the aggregate and acquaints the plant inspector of any bin changes. This procedure provides for the mix to be altered, if necessary, to meet changed material conditions. The materials checker is on the weigh platform at all times or in such close proximity thereto that the state is assured correct weight. A ticket in duplicate is filled out giving job name, number of tons, class of mix, truck number, and truck driver's name. The original is given by the driver to the road inspector who then makes out the pay ticket and gives it to the contractor's superintendent or foreman. From these material tickets the contractor's estimate is prepared. At the end of each day's run the road and plant inspectors check the day's output.



Planometer in Background. Planer Float, Used on Concrete Roads, in Foreground

Satisfactory Mixes.—Mixes that have proven satisfactory for our conditions follow:

A, B, C, D, E, 1¼ in. cutback asphalt wearing surface and ¾ in. cutback asphalt wearing surface.

CLASS OF MIX USING INDICATED PER CENT OF VARIOUS SIZES

Screen Size	A	B	C	D	E	1¼-In. Caws	¾-In. Caws
2½-in.-1¼-in.	....	....	....	....	....	....	....
1¼-in.-¾-in.	16-24	....	12-20	18-28	....	20-30	....
¾-in.-¼-in.	24-36	26-38	18-28	24-32	30-42	30-46	45-55
¼-in.-No. 10	12-20	22-30	10-16	12-20	18-28	15-25	35-35
No. 10-No. 200	20-28	25-35	16-24	20-30	24-32	8-12	10-14
Pass No. 200	3- 6	4- 7	2- 4	2- 4	3- 5	0- 4	1- 3
A. C.	4.5-6.5	5- 8	3- 5	4- 6	5- 7	4- 6	5- 7

SAND GRADING USED IN ALL THE ABOVE MIXES

Screen Size	Per Cent
No. 10-No. 40	30-50
No. 40-No. 80	16-32
No. 80-No. 200	16-32
Pass No. 200	8-16

Placing the Mixture.—Upon arrival on the road the mixture is distributed either by truck or spreader box. The material is then placed by hand raking, or spreading machine if a lower course, but by machine only if wearing surface.

These spreaders are very simple and have been made by two of the contractors at small cost. Powered by a small gasoline motor, they travel by flanged wheels on the headers or on wooden strips, and are no more than a traveling screen without any transverse movement. If carefully set the spread mix is exceptionally smooth.

Rolling.—Rolling is, of course, longitudinal, starting at the outer edges and working in, but is not attempted while the mixture is too hot. The minimum temperature at which the mixes using "D" 51-60 penetration asphalt may reach the road is 225° F. Using RC-4 cutback asphalt, the temperature of the mix, upon reaching the road, should be between 125° and 175° F.

In the rolling of the cutback wearing surface a slightly different procedure is advisable. The best practice seems to be to break down the material, then remove the roller and let set for approximately six hours, depending on atmospheric conditions. Then bring back the roller and compress as usual.

Checking Surface.—Just before the completion of the final rolling, the surface of the pavement is checked with the planometer (see illustrations) and any high places are taken down and depressions built up until the surface is not off longitudinally more than seven one-hundredths of an inch in any 10 ft. section. Asphalt is kept from sticking to the rubber tired wheels of the planometer by keeping their surfaces dampened with water or kerosene by the use of pads which rest lightly on them.

The cutback wearing surface when correctly designed, mixed and laid is non-skid for many years providing the excess asphalt is removed from the surface of the underlying pavement, or its bad effects neutralized by a very lean leveling course.

Cover Material.—Upon the rolled cutback asphalt wearing surface, we have found it quite advantageous to apply hot 10 to 200 mesh material at the maximum rate of 4 lb. per square yard. This is either coated or not as the exigencies of the mix demand. If coated, 0.25 to 2 per cent RC-4 cutback asphalt is used. The effect of adding a binding medium to the cover coat is two-fold: to keep the material from being too dusty, and to add a very slight stickiness. RC-4 is used in this cover coat because it is readily available at the plant. "D" 51-60 would undoubtedly serve as well.

The necessary quantity of cover material varies with the mix. In general, a more open mix requires more material to fill the interstices in the surface. A binding medium is always used in the cover coat in municipalities to eliminate as much dust as possible. In either case, coated or uncoated, the amount used is just sufficient to fill the void in the surface. The material is shoveled out of trucks and spread by the use of 6 by 10 in. boards about 2½ ft. long with a handle attached, the excess sand being immediately removed.

Using the above methods and mixtures we obtain sightly and smooth riding roads.

▼

Rating Grade Crossings for Priority in Elimination

It is frequently found desirable to rate various grade crossings by priority particularly when arranging a program for elimination or protection. As every crossing has different features affecting the hazard, it is very difficult to make a comparison without some definite method of rating. The engineering staff of the Illinois Commerce Commission, sometime ago developed a formula which takes into consideration the various factors. An interesting discussion of this formula and its application was given by Roy A. Klein, Senior Highway Engineer, U. S. Bureau of Public Roads, in a paper presented at the 1935 Annual Highway Conference at the University of Colorado.

The method for determining hazard rests upon two general propositions: (1) that there are two principal elements in the hazard to the public at a grade crossing —that arising from the physical conditions, such as obstructions to view, steep grades, intersecting highways and sharp curves on the approach, and the volume of traffic, both on the highway and on the railroad that passes over the crossing; and (2) that the degree of hazard to each individual traveler for a given set of physical conditions increases substantially in proportion to the number of trains per day moving over the crossing, and that the danger to the general public increases in proportion to the number of highway travelers per day. Thus the index of hazard with respect only to vehicular traffic is equal to the hazard arising out of physical conditions, multiplied by the number of trains multiplied by the number of highway vehicles.

In determining the formula, it was assumed that the hazard arising out of physical conditions at each crossing with respect to vehicles may be considered as the sum of four general elements which make for hazard. These are the inherent hazards (1H) always present at every crossing, the view factor (S) or danger arising by reason of obstructions, the attention factor (A) or the various physical conditions at crossings which may affect the attention of the driver, and the user factor (U) which covers any particular manner of use of the crossing by either the railroad or the highway traveler which affects the hazard.

The Illinois formula may be expressed as $IH = VT(1H + 4S + 4A + 1U)$ in which "IH" is Index Hazard and "V" is Vehicular Traffic and "T" is Train Traffic, both for 24 hours. In applying this formula the factors were given weights as follows: Inherent hazard 1, view factor 4, attention factor 4, and the user factor 1. To apply the formula to Western conditions these values are accepted in the absence of any conflicting data. The other values have been considered as follows: To hold the index of hazard to a smaller figure, the product VT is divided by 100. To determine S, the sight distance has been taken as the shortest distance at which the driver can see a train approaching in either direction from a safe braking distance from the tracks. This is expressed as $S = \frac{1000 - d}{1000}$ to reduce to a decimal, thus for a sight distance of 200 feet, $S = 0.8$ or for a sight distance of 700 feet $S = 0.3$, 1000 feet being considered the safe sight distance.

The value of A is built up of various factors affecting the crossing as described above, in percentages of 1, unity representing the worst condition and 0 the best; thus, a crossing having a sharp right-angle turn on the approach, but with other physical conditions good, might be rated as 25 per cent or $A = .25$. If another dangerous condition is found such as a steep descending grade on the approach, another 25 per cent should be added, or a total value of $A = .50$. U, the use factor, is also rated in percentages of 1, unity representing the worst condition and 0 the best. Thus on a crossing where high-speed trains are frequent, a value of 50 per cent may be assigned, or $U = .50$.

It will be noted that the assignment of values to A and U is largely a matter of judgment, but if the corresponding data is used impartially, the resulting figure should show a comparable rating when reduced to the final figure, the index hazard. This will be found helpful in arranging a priority listing of crossings having widely different physical conditions and varying train and vehicular traffic.

APPLICATION OF RAINFALL CYCLES TO PROBLEMS OF WATER SUPPLY

By HALBERT P. GILLETTE

"PEOPLE are always talking about the weather, but never do anything about it," said Mark Twain. Some people must have taken this remark seriously, for not a few have been doing a good deal about weather these last two decades. Our own government has been spending nearly $4,000,000 annually on weather investigation for many years. Most of this expenditure has been for the gathering and publishing of data as to rainfall, temperature, pressure, etc., throughout the United States. The object has been to enable forecasters to tell what sort and quantity of weather to expect. This is literally true, whether the forecast is a warning to carry an umbrella tomorrow morning or a forecast as to the runoff from a given watershed during the next pentade. Unfortunately, however, all this expenditure of money has brought us results that are still very unsatisfactory. We know what the average annual rainfall has been for at least three generations in nearly every region in America, but we don't know with much accuracy what it will be next year in any region. We do not even know how much rain will fall anywhere tomorrow, with sufficient assurance to feel safe in betting even money on the forecasts being within 50 per cent of the truth. Our Weather Bureau dares not prognosticate more than about three days in advance, and even then merely tells that it will or will not rain, or discreetly says nothing about rain further than to warn us that it will be cloudy.

So far as government forecasts are concerned, I have never seen one that was worth a dime to any water department, with the possible exception of one made a few weeks ago by J. B. Kincer, Chief of the Climate Division. On July 21 many newspapers carried the following item under the caption. Next Year's Weather: "Generally fair and warmer for the next few years is the long time weather prediction made here today by J. B. Kincer, chief of the United States Weather Bureau's Climate Division.

"Speaking of general weather trends, Kincer said that the past quarter of a century has shown unmistakably that summers are getting warmer with a corresponding decrease in rain. Kincer believes the weather moves in huge cycles covering periods of a hundred years or more."

About a month earlier, June 26th, I read a paper before the American Meteorological Society, entitled "The Cycles that Cause the Present Drought." The paper was printed in full in the August issue of WATER WORKS AND SEWERAGE. In that paper I gave enough evidence to establish the existence of a rainfall cycle 152 years long, which had its last time of extreme drought in 1787 and will therefore reach its next extreme in 1939. In that paper I showed that rainfall near Boston, from 1750 to 1934, gave evidence of this "grand cycle," and that the annual highwater levels of the Nile in Africa showed it since 1736. More significant than any man-kept records like these are the nature-kept records which tree-rings and annual silt layers in lakes furnish; for such records go back to 1310 B. C. in the case of trees and to 10,000 B. C. in the case of silt-layers, or "varves."

In 1910 an Australian civil engineer by the name of Keele published evidence of this "grand cycle" as he called it. In 1914 Huntington of Yale found it in the Arizona pines back as far as ring measurements had been made which was back to about A. D. 1400. I found it in the giant redwoods, or sequoias, of California, the earliest drought maximum of this cycle shown by their rings being 1255 B. C. This enabled me to determine the length of this cycle with great accuracy. It is just a month longer than 152 years.

In my paper of June 26th, I ventured the prediction that rainfall will be subnormal for about 40 years, because of the 152-year cycle. I pointed out that a cycle of about 70 years in length had its drought maximum in 1934, and had been consequently assisting the 152-year cycle in causing subnormal rainfall.

In Table I data as to 13 rainfall cycles are given. From these data it will be seen that even the 152-year cycle never can produce an unbroken drought for, say, 10 years, because the rainfall peaks of two or more shorter cycles fall so near together at intervals as to bring short periods of wet weather.

The amplitude of a rainfall cycle is the departure of the peak or valley of the cycle curve from the mean rainfall. The accompanying table shows that the amplitude of such a cycle tends to be greater, the longer the cycle. That is why the 152-year cycle often discloses itself at a glance even where the data cover no more than 150 years. But man-kept data covering 150 years in America have been available only within the last few decades, and then only as to New England. Small wonder that Marvin and others of the Weather Bureau who have plotted rainfall curves in America have hesi-

TABLE I—THIRTEEN RAINFALL CYCLES

Basic Cycle, Years		Mean Amplitude, Per Cent	Amplitude Cycle, Years	Rainfall Maximum, A.D.
	35/18	4	35	1911
	19/6	6	19	1900
4	1/9	7	37	1922
5	13/18	6	103	1919
7	5/9	6	68	1921
13	11/12	8	167	1816
18	5/6	11	113	1889
23	5/6	12	143	1859
39	2/3	10	119	1921
48	5/6	12	293	1756
69	2/3	15	209	1760
100	2/3	13	302	1912
152	1/12	25	1825	1711

Footnote: The mean amplitude is the percentage departure of the cyclograph peak or valley from the mean. Cyclographs were those derived from Arizona pines (1391-1910) except for the 100 2/3-year cycle, for which early sequoias were used; their cyclographs usually have amplitudes about 2/3 those of the Arizona pines; hence the 13 per cent should be increased about one-half. The amplitude varies periodically through the cycle in the third column. The last column gives a date when a peak of the basic cyclograph had its greatest amplitude, and is to be used as an "epoch" date.

[While this paper, presented on Oct. 16 at the annual convention of the Pennsylvania Water Works Association was intended primarily for Water Works men, it nevertheless contains important facts that are of interest to highway engineers and contractors. It may be noted that the paper received a great deal of attention at the convention and caused much discussion, and in addition it was considered of sufficient importance to warrant the broadcasting of a portion of it on the March of Time program on Oct. 18.—Editor.]

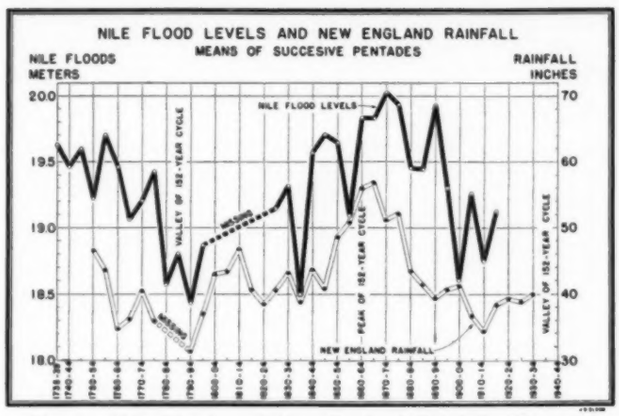


Fig. 1.—Nile Floods and New England Rainfall—Means of Successive Pentades.

tated to come out as boldly as Kincer did July 21 with an expression of belief in rainfall cycles of 100 or more years in length.

The only fault I have to find with the Weather Bureau is its failure to have gathered nature-kept records of weather variations, in the form of measurements of tree-rings and varves. Had the Bureau spent a tenth as much money doing that as it has spent reading thermometers, barometers, anemometers and raingages, I believe that a forecast such as Kincer made last July would have been made fully 25 years ago.

To Professor A. E. Douglass, of the University of Arizona, must go the highest praise for pioneer work in measuring tree-rings with a view to discovering rainfall cycles. His first important publication on this subject was issued in 1919. His work has been repeatedly acclaimed as the most likely to supply data needed in discovering weather cycles. My own use of his data during the past 9 years has convinced me that both for the purpose of discovering cycles and for determining their length with precision, tree-rings are so vastly superior to man-kept records as to make the latter almost worthless except for very short cycles. There is, in fact, only one other type of weather record at all comparable to tree-rings for this purpose, namely, the annual silt laminae, called varves, that are to be found both in existing lakes and in the beds of lakes that have ceased to exist. Of these ancient lake beds the most prolific in weather data are those deposited during the last Ice Age. De Geer of Sweden has measured an unbroken series of such varves that covers 12,000 years. Antevs has made similar measurements in New England and Canada, covering about an equal period but with several gaps in the record. His longest unbroken series covers 3,700 years. I find the varves almost as useful as tree-rings in determining the existence and length of cycles.

Many sedimentary rocks are seasonally varved, as, for example, the oil-shales of Colorado. By their aid it will be possible to determine the length of the Ice Age cycle, I believe. Already there is good evidence, supplied by them, of a cyclimatic cycle of 21,000 to 26,000 years. I have reason for believing that its length will prove to be the period in which the earth's axis makes a complete gyration, which is about 25,700 years. While as practical men we may think we are not concerned with cycles of that length, yet as users of scientific theories we really are concerned; for if this rain cycle is about 25,700 years it follows that its cause must be magnetic, for every 25,700 years the opposite poles of the sun and earth point most directly at one another in midwinter and midsummer, causing the greatest magnetic pull of the sun upon the electron-shells that encase the earth. Under such a condition, since the earth is constantly emitting electrons, there would be a maximum effect upon the currents of electrons and therefore upon the air. I will not go farther into the details of this electron theory of weather further than to say that electrons from the nuclei of raindrops.

It must be evident even to the most practical man, that a knowledge of the cause of rainfall cycles is bound to lead to better methods of weather forecasting. But even before we come to an agreement as to the causes of cycles we can use cycles for forecasting. Indeed we shall never be able to make long forecasts unless we know the approximate lengths and amplitudes of all the important cycles. With this goal in view I have spent many years in the analysis of tree-rings, varves and weather data. There is a very simple method of analysis, devised years ago by Balfour Stewart, which I described in my paper of June 26th. It is exceedingly laborious, for it is a "cut and try method," but I have found no other method as satisfactory.

I am occasionally asked why it is necessary to use any mathematical method of analysis to find a rainfall cycle if the cycle is really worth the finding. The answer is that where 13 or more cycles of varying lengths and amplitudes exist, they camouflage one another. Let the rainpeak of one occur at the rain valley of another of about the same amplitude, and the result is that the one offsets the other. Let a dozen or more play this sort of hide-and-seek with one another, and the result is a rainfall curve that often looks like the profile of the Rocky Mountains—a series of ups and downs devoid of reason. Fortunately every cycle is itself cyclic as to its amplitude. That is to say its amplitude waxes and wanes in a regular manner. I find that the 152-year cycle caused very large glacial moraines about every 1,825 years, and quite small ones at times intermediate between two such maxima. The so-called 2-year cycle, which is really 1-17/18 years, has its highest rain peaks every 35 years. I say this is fortunate, for it tends to bring into prominence each cycle at intervals. Were it not for that—and because "hope springs eternal in the human breast"—I believe that searchers for rainfall cycles would have given up in despair long ago. Douglass might not have thought it worth while to measure tree-rings had he not read about rainfall cycles that had disclosed themselves for a brief time and then disappeared. As far back as 1500 B. C. Joseph evidently had seen evidence of a 14-year cycle, for otherwise his interpretation of Pharaoh's dream of the 7 fat kine and the 7 lean kine would probably not have been made.

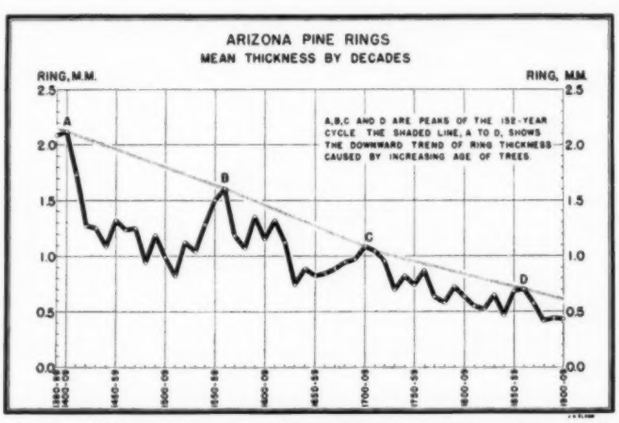


Fig. 2.—Arizona Pine Rings, Mean Thickness by Decades. A, B, C and D Are Peaks of the 152-Year Cycle. The Broken Line, A to D, Shows the Downward Trend of Ring Thickness Caused by Increasing Age of Trees.

Curiously enough the Indians told De Soto in 1543 that great floods of the Mississippi occurred every 14 years. I have found in the sequoias and pines a cycle that is just one month short of 14 years!

A besetting error in cycle research has been the belief that cycles are few in number. Another misleading hypothesis has been that short cycles are aliquot parts of long cycles; e.g., that there is a rain cycle just half the length of the sunspot cycles of 11.2 years and of an alleged rain cycle of that length. I am now convinced that neither sunspots nor any variation in heat emitted by the sun, nor the force of any planet is the cause of any rainfall cycle of importance. The fact that every one of the 13 cycles in the accompanying table is exactly harmonic with the earth's orbital period seems to me to rule out every alleged cause but one, namely, the gyration of the axes of electron-shells that encase the earth, such as the shells that reflect radio waves. But I do not intend discussing the cause of cycles now.

How can we make sure that the alleged cycles are real? Are all regions affected similarly by cycles? Should additional tree-rings be measured? Where and by whom? Are the dry years of the near future apt to be worse than those of the recent past?

Although the number of cycle researchers has always been few, it has been an enthusiastic group and has slowly increased. Once a believer in weather cycles, always a believer, in spite of the skepticism of those who never have spent much time in cycle research. This in itself is pretty good evidence either that cycles exist or that all who have become cycle researchers are "nuts." There have been so many probability calculations showing the reality of certain cycles that whoever understands that criterion can have no doubt that weather cycles are not all illusions resulting from chance repetitions. On the other hand most alleged cycles have been published without either probability calculations or curves that repeat themselves often enough to give prima facie evidence of the reality of the alleged cycle. The only tests of cycle reality that are universally recognized as satisfactory are two (1) Repeated agreement of forecasts with the subsequent events; and (2) high odds that the agreement of the alleged cycle with previous events is not accidental. In the final analysis these tests are identical, for both call for a substantial agreement between theory and fact. Unfortunately the first of these tests is usually inapplicable until all or nearly all important cycles have been discovered. For example, suppose the so-called 70-year cycle had been established, but it was not known that a cycle of 152 years exists. Then a forecaster would have predicted subnormal rainfall in most regions centering about 1934, followed by a slow return to normal rainfall in 1952. But since there is a rain cycle of 152 years having its center of subnormality in 1939, and having a greater amplitude than that of the 70-year cycle, the forecaster would err seriously in predicting normal rainfall by 1952. Multiply these two cycles by at least six and you will see why the existence of a cycle can not well be proven by forecasting. You must know all the important cycles and their amplitudes before your forecasts for any given year will be very satisfactory. So the second method of testing an alleged cycle is the only one that can be applied to any cycle except one of exceptionally great amplitude, like the 152-year cycle, and not always then. Any engineer who will study Frey's "Probability and its Engineering Uses," should be competent to test the reality of any alleged cycle. Unfortunately few cycle researchers have thought it necessary to submit their findings to any such mathematical test. They have usually published only a few curves of rainfall indicating alleged cycles, based on data covering only a few, say, 6 cycles. This is usually unconvincing. I have found it difficult to secure satisfactory probability results unless the data embraced at least 20 cycles. The outstanding exception is the 152-year cycle. From experience I have learned to have little faith in man-kept records for use in determining the existence of rain cycles that are more than about 10 years long.

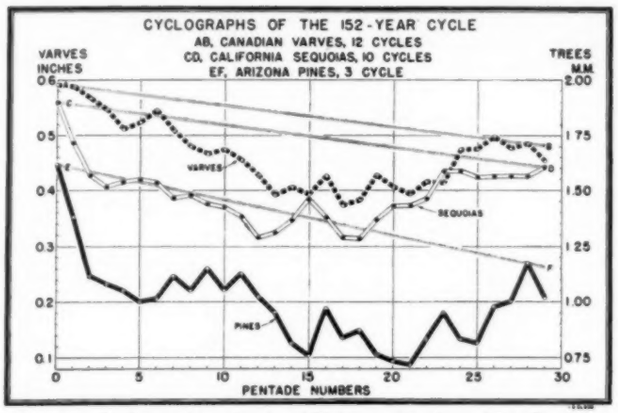


Fig. 3.—Cyclographs of the 152-Year Cycle, AB, Canadian Varves, 12 Cycles; CD, California Sequoias, 10 Cycles; EF, Arizona Pines, 3 Cycles.

This leads to the conclusion that tree-rings should be measured in every region on earth, for it is an undoubted fact that some regions often have supernormal rainfall when rainfall is subnormal in other regions. Clayton explains this by the existence of "centers of action" that have opposite effects on air currents, namely, the semi-permanent cyclones and anticyclones. The semi-permanent anticyclone whose center is about 1,000 miles west of the northern coast of California in summer accounts for the very light summer rainfall in California at a time when Texas, in the same latitude, is receiving its heaviest seasonal rainfall.

Owing to the fact that so few tree-rings have been measured east of Arizona, I am in doubt as to what regions will show the same rainfall peaks for the 13 cycles in the accompanying table. New England, Africa, Australia, California and Arizona undoubtedly show the 152-year cycle with peak and valley dates that are about the same; but Clayton in his recent monograph, "World Weather and Solar Activity," says that although mean pressures and temperatures have been rising in many regions for 42 years, there has been a downward trend "in the cold areas of high latitudes." This indicates that we must make tree-ring measurements in every region, before we can solve the effect of a given cycle in different regions.

In many regions trees are comparatively short lived and therefore not very satisfactory recorders of weather. But in such cases rings in logs buried in wet soils in river beds, lakes and swamps should be measured. Where their outer rings overlap the inner rings of growing trees, it is often possible to match similar rings and thus carry the record back several hundred years, as Douglass has shown in such a remarkable manner. But even where such overlapping of periods of growth cannot be found, it should be possible to close the gap between living trees and dead logs by aid of the cycles given in the accompanying table.

Although tree-rings in semi-arid regions record rainfall variations better than in humid regions, I doubt not that the technique of tree-ring research will become so-developed as to render trees in humid regions good indicators of rainfall cycles. It has been found that

where a curve of tree-ring thickness does not match a curve of annual rainfall very well, it may match a curve of rainfall during the spring and summer months; that is during the growing season.

The rings of young trees are not only thicker than those of old trees, but match the rainfall curve much better. When a tree is deeply rooted it is evidently less affected by variations in rainfall. This is strikingly evident in the California sequoias and Arizona pines. Hence many more of these trees should be measured, selecting for the purpose trees of varying ages. In humid regions it is probable that trees on the south slopes of hills will indicate the rainfall of the growing months better than those on the north slopes or on level ground. On the other hand, since snow lies longer on northern slopes, trees on such slopes should reflect snowfall variations and thus be good indicators of winter precipitation.

In humid regions there are some kinds of trees whose rings are thinner the heavier the rainfall. But where this is found to be the case, they may be as satisfactory for determining cycles as where the opposite is the case.

Nearly all tree-rings thus far measured have been measured on stumps of trees. In the future most of the measurements will be made on cores taken from growing trees by means of an auger devised for this purpose. Mr. Clem Copeland, Research Engineer of the Bureau of Water and Power, Los Angeles, has directed the measurements of tree-rings on the east slope of the Sierras in the Owens River Valley region, and for this purpose has used an auger that bores through a tree 12 ft. in diameter. A thin section of each core is shaved off and mounted between strips of glass, so that it can be used as a "magic lantern" slide. The rings are projected upon a ground glass screen, and are so greatly magnified that they can be measured with great accuracy. I was greatly pleased to learn that his analyses had disclosed a cycle of about 70 years, for only two other researchers beside myself had mentioned finding a cycle of about that length. One of those two had regarded it as being a cycle that varies enormously in length, whereas I found no evidence of variation in length either in this cycle or in any other cycle. The other researcher is a Russian by the name of Pervilief who in 1927 had found good evidence of a 70-year cycle in the annual silt layers (varves) in Sakski Lake in Crimea. Incidentally he is one of the very few who have measured varves in existing lake beds. I infer that the Sakski Lake level has receded sufficiently to permit the measurements of varves above the present water level, but I have no doubt that in the future cores will be secured from lake beds under water, either by augers or by driving pipes into the silt. I shall not be surprised if varve thicknesses thus secured prove to be more satisfactory than tree-rings.

It is 16 years since Prof. Douglass published his now famous monograph, "Climatic Cycles and Tree-Growth," in which he conclusively established that the thickness of tree-rings in northern Arizona was correlated with rainfall in that region. Yet not a single weather bureau in the whole world has undertaken to make tree-ring measurements This is nothing short of astounding.

It is 23 years since Prof. Gerard de Geer of Stockholm published "A Geochronology of the last 12,000 years," in which he gave measurements of annual varves in ancient lakes. Both he and Douglass pointed out the 2-year cycle, the one in varves, the other in tree-rings, which had also been observed by meteorologists both as to temperature and rainfall. Yet not a single weather bureau has yet undertaken to measure varves! This also is astounding.

I am hopeful that our Weather Bureau will soon begin the measurements of tree-rings and varves; but even if the Bureau does undertake this task, the job is so great that progress is apt to be slow. Consequently, I would suggest that there be organized in each state a small staff of research engineers to make ring and varve measurements and to analyze the results. If the city water departments and water companies would each contribute a very small sum annually, the total would suffice to support a research staff that would unquestionably secure data worth many fold the cost of the research.

May I suggest that the Pennsylvania Water Works Association be the pioneer state organization to initiate such a research as I have suggested?

In 1892 my father built a water works in Washington, and some years later asked me to compute the amount of water that could be safely counted upon as the available runoff from the watershed, in case a dam were built to raise the level of the lake that served as the reservoir. Rainfall records in that region ran back only about 25 years, but that seemed to be long enough to furnish adequate data. How wrong that assumption was, little did I dream; for in those days no one was writing engineering articles about rainfall cycles, and very few meteorologists were discussing the subject. No Douglass had shown that tree-rings could be used as criteria of rainfall, although it is true that an article had appeared 52 years before in Harper's Magazine telling how a German had found that tree-rings in Texas disclosed rainfall cycles. But that lone voice in the wilderness of ignorance about cycles had not then reached my ear. So, although there were trees of great age all around our reservoir, it never occurred to me to measure their rings. I merely did what other hydraulic engineers were doing—looked up the man-kept records of rainfall and used them as my sole guide. The trend of rainfall in the Pacific Northwest, as in many another region, has been slowly but not always regularly downward ever since that time. Hence the data that I used were very deceptive. The miscalculation that I then made is typical of scores made by other engineers, some of which have proved very disastrous to investors in irrigation and water-power projects, and quite painful to many owners of city water works.

I see in memory many an old "mass diagram" based on elaborate, hair-splitting calculation, that subsequent results have shown to be no better a guide than a Chinaman's guess. Unfortunately, that sort of guesswork has not entirely ended, and will not end until engineers know more about weather cycles.

At the present moment, I can perhaps render no greater service than by shouting from the tree-tops about the 70-year and the 152-year cycle that the trees themselves have recorded; for there is widespread belief that the drought is broken. The newspapers of the middle and far west have recently been telling their readers that at last the drought is broken. A drought that has been slowly coming up for many years will not suddenly whisk away into oblivion. On the contrary it will take as long to go as it took to come. Common sense should tell the newspaper editors that, and it would tell them just that if they were to study such curves as the two shown in Fig. 1. Here you see that near the last peak of the 152-year cycles, the average annual rainfall near Boston was about 56 in., whereas near the last valley it was about 31 in., or about 55 per cent as much as at the peak. Note that these annual averages are averages based on 5-year periods or pentades. Unfortunately Boston rainfall records for two pentades, or a decade, are missing; but for our present

purpose this need not worry us. The flood levels of the Nile in Africa also show a similar cycle. But better than either of these man-kept records—far better—is the nature-kept record shown in Fig. 2. There you see the last four rain peaks of the 152-year cycle, as recorded in the Arizona pines. Note particularly the striking way in which these pines recorded this cycle when they were young and not deeply rooted. The amplitude of this cycle in these pines is greater, but not much greater, than the amplitude in Boston rainfall. In semi-arid regions rainfall cycles have greater amplitudes than in humid regions. Moreover individual years show greater extremes in semi-arid regions. In Los Angeles the rainfall of the wettest seasonal year ending June 30 was nearly 38 in. whereas that of the driest year was less than 6 in. Boston's wettest calendar year had nearly 68 in. as compared with about 24 in. in the driest year, which was in 1762.

At one time it was believed by some meteorologists that the very low rainfall recorded in early years was due to defects in gaging or in measuring snowfall. That belief has largely disappeared. Where it still survives tree-ring measurements will bring it to an end.

Impressive as are data such as are shown in Figs. 1 and 2, even more impressive are the recessional moraines left by the great ice-sheet that covered New England during the last Ice Age. Here it was that I found the most striking evidence of the amplitude of the 152-year cycles. In my paper of June 26th you will find a discussion of this evidence, and of how I was able to determine, by aid of varves, the length of the cycle that caused the series of 14 recessional moraines in the Berkshire Hills. These moraines are great dams across valleys, the dams being deposits of gravel, sand and clay left by the ice-sheet during times when increased snowfall and lower temperature caused the ice-sheet to retreat very slowly, or even to halt its retreat entirely. These morainal dams are often 200 ft. high and more than a mile wide at the base. Not infrequently such dams still hold water in the form of lakes and ponds in New England, New York and elsewhere. Occasionally there is such a dam at the head as well as the foot of a lake. You cannot see such huge dams without realizing that the weather cycle whose maximum effect caused them was indeed a "Grand Cycle." Keele was greatly impressed by the evidence of this cycle in the rainfall of Australia and in the levels of the Nile; so impressed that he called it the "grand cycle." Could he see the huge moraines that it has caused, he would be much more impressed by its importance.

We boast of the rapid strides that all sciences have taken in the last generation, but let us be not too boastful. Twenty-five years ago an Australian civil engineer told the world of a discovery that he believed he had made—a very important discovery, none other than "a grand cycle" of rainfall. But the world gave no heed to him. Perhaps he is dead now. Dead or alive, I take off my hat to T. W. Keele of Australia.

Twenty-one years ago Dr. Ellsworth Huntington rediscovered the "grand cycle" in tree-rings, and published his discovery. But the same lack of interest greeted him as had greeted Keele.

Sixteen years ago Prof. A. E. Douglass published the monograph above mentioned. Here and there it was acclaimed a great piece of research work; but I question whether even yet it has been read by one meteorologist or one hydraulic engineer in a hundred.

So, I say, let us be not too boastful about our scientific progress. We are simply repeating history. It seems to take about a generation for us to get around to reading and acting upon what we read when it relates to a revolutionary discovery in the field of observational science. Schwabe's discovery of the sunspot cycle had that sort of history. So did Agassiz's discovery of the Ice Age. Each successive generation smiles at the slowness of last generation and goes right on being slow itself. Apropos of this let me quote from an article in the March, 1867, issue of Harper's magazine, page 500:

"He (Hoogenboom) has told me about it (a section of oak) before. There were 80 or 100 rings, showing the growth of the tree for that number of years past. He could tell the wetness or dryness of all the seasons for that time back by the comparative thickness or thinness of the rings. He had made out a table, and found that the seasons went wet or dry in separate groups of 6 or 8 years each; but that a large number of the groups had been very wet, and a majority of all favorable in the highest degree. He says similar experiments all over Texas have proved the same, and that he has tested his tree-almanac by what is well known in regard to seasons for the 20 years. Its rings for that time and the (rainfall) facts agree. He is a learned man, Hoogenboom; it's his broken English makes him seem ignorant. I think a great deal of him."

Hoogenboom was evidently a man whose scientific insight was very acute. Not till almost half a century later was the "tree-almanac" idea taken up by Prof. Douglass, and made the basis of an extensive scientific study in Arizona, California, Germany and elsewhere. Even yet, both hydraulic engineers and meteorologists have quite generally failed to investigate the possibilities of tree-rings as guides in unraveling weather cycles.

Based upon a study of the cycles in the accompanying table I infer that the next 10 years will be the driest decade that we have had in a century and a half. This does not mean that every year of the decade will be subnormal, nor that all localities will be subnormal in rainfall. However, it does mean that it will be wise to provide additional water supply wherever the supply has been short or verging on insufficiency during recent years, unless metering can be counted upon to take care of the prospective deficiency by reducing wastage.

Distribution of Motor Vehicle Revenues

Receipts of the various states for motor fuel taxes in 1934 amounted to $566,599,000. New York collected the greatest amount ($43,628,000) and also diverted the greatest amount ($29,322,000) for other than highway purposes. The following table shows the collection and distribution of 1934 gas tax:

Balance undistributed at end of previous year	$ 41,021,000
Receipts of calendar year	566,591,000
Total funds available for distribution	$607,612,000
DISTRIBUTION OF FUNDS	
Collection and administration	$ 4,690,000
State highways	263,712,000
Local roads	105,097,000
City streets	24,243,000
State and local road bonds and notes	81,537,000
For other than highway purposes	94,357,000
Balance undistributed at end of year	33,976,000

Motor vehicle fees collected by the states in 1934 amounted to $309,010,000. There was a balance undistributed at end of previous year of $16,505,000, thus making the total funds available for distribution amount to $325,515,000. The distribution of the funds from motor vehicle fees was as follows:

Collections and administration	$ 21,844,000
State highways	130,989,000
Local roads	73,682,000
City streets	5,694,000
State and local road bonds and notes	36,357,000
For other than highway purposes	42,168,000
Balance undistributed at end of year	14,781,000

COUNTY QUARRY REDUCES RELIEF LOAD

THIS is a story of the method adopted by the highway department of a county in Iowa to help solve the work relief problem. Practically every county in the entire country is confronted by a similar problem —namely how to give work to the unemployed and at the same time not waste the taxpayers' money.

Lucas County, Iowa, solved the problem by purchasing a quarry and employing the needy in the production of road material for use on the county's system of highways. There is no patent on this method of handling the situation. Road improvement is the most obvious solution of the unemployment problem and many counties are undertaking it. The solution is not difficult where there is plenty of money available; but most counties are situated as is Lucas, with a relatively large number of families on relief, limited resources, and a growing demand from taxpayers that they be given something for their money.

A. R. Bartell, County Engineer, had been considering the plan for some time but previous to last Winter the highway department was unable to buy the necessary equipment. Whenever the Road Fund showed a surplus the money was transferred to the Poor Fund and the highways had to wait. Last Winter, however, the Iowa State Legislature prohibited the diversion of taxes to any purposes other than that for which it had been levied.

After the passage of this law, the Board of Supervisors felt justified in going ahead with the plans for a county-owned quarry. A tract of 27 acres, containing excellent stone, was purchased in Pleasant township, in the northeast part of the county. Under an average of about 6 ft. of overburden and 3 ft. of sand rock, there is a ledge of blue limestone ranging from about 20 ft. to 40 ft. in thickness. The ingenuity displayed in getting the quarry stripped and in setting up a suitable crushing plant, within the means of the county, is worth recording.

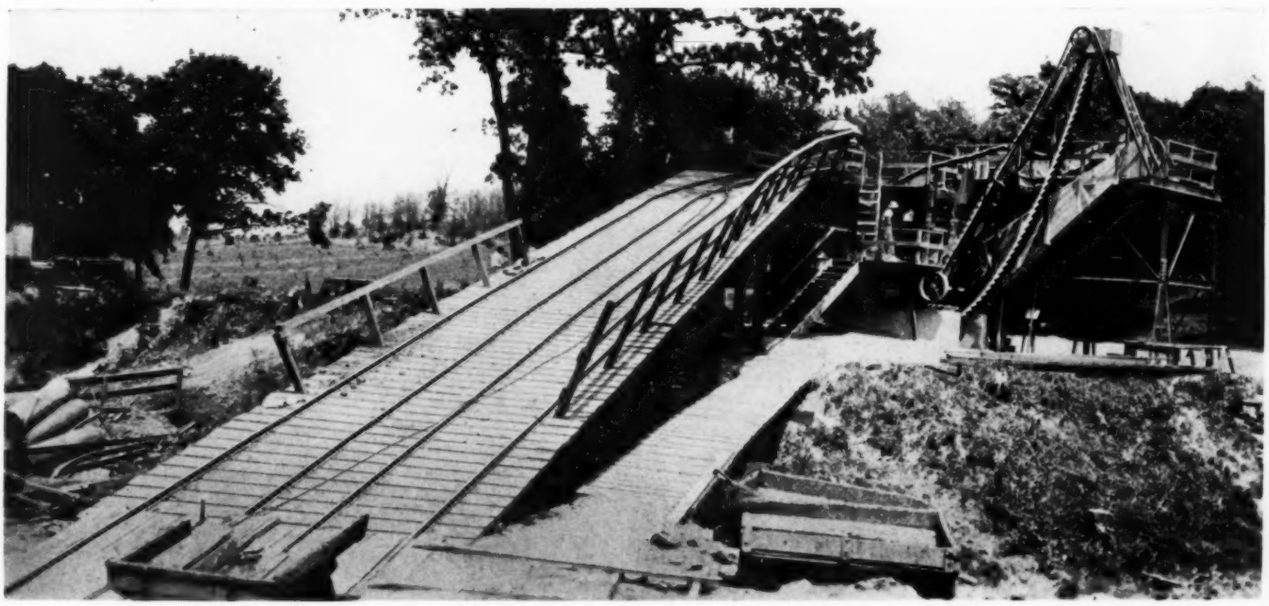
The stripping was done with a Koehring dragline, loaned by the state on a trade basis. In return for the use of the dragline for 30 days, the county loaned the state an elevating grader, tractor and wagons, to be used in the construction of a dam just east of Chariton, the county seat.

The plant was constructed according to the combined ideas of the Board of Supervisors, the County Engineer, and W. G. Wertz, Foreman of the county shop. A "home-made" compressor outfit was built in the shop, a used compressor tank elsewhere. These were mounted on an old "Iron Mule" that had seen its best days and had been rebuilt for the purpose. For the crusher unit, an Austin-Western 9-in. by 40-in. roller-bearing jaw crusher was installed. This improvised portable plant is doing very satisfactory work.

The plant has been set up across a small stream, well above high water and within easy reach of a highway. Relief labor is employed at the quarry to break the large pieces of blasted rock to a size that will enter the crusher and in loading the material into small mine cars for transportation to the crusher. From 35 to 50 men can be used advantageously in this work.

The cars of stone reach the plant over a ramp about 175 ft. long, up which they are pulled at a speed of about four miles an hour by a home-made hoist, driven by a chain from the crusher. The rock is dumped directly into the crusher and a bucket elevator delivers the product to a gyratory screen. The accepted sizes drop into the loading bin and the oversize is returned to the crusher.

Five regular county employes are used at the plant: One operates the hoist, power for plant and hoist being furnished by a tractor. This man has a clear view of the entire operation and in addition to his other duties has charge of an alarm which is sounded in case of emergency. One man feeds the crusher, one operates the jack-hammer. In addition to these there is a timekeeper and a foreman. The relief rolls furnish the common labor. It is necessary to have regular employes handle the explosives because workmen's compensation insurance applies only to those regularly employed.



General View of Plant from the Quarry

Another View of the Plant

The crushed stone produced is delivered to the county roads in trucks and used for surfacing. An excellent system of highways is resulting and at the same time work is provided for from 75 to 80 per cent of the relief load at its peak. On the return of normal conditions, the county plans to use a small power shovel for loading at the quarry and continue operations on an extremely low-cost basis.

The members of the Lucas County Board of Supervisors are O. H. Cottingham, chairman; Charles Lyman and F. C. Conrad.

Topics to Be Discussed at Meeting of Highway Research Board

The 15th annual meeting of the Highway Research Board will be held in Washington, D. C., at the building of the National Academy of Sciences and National Research Council on Thursday and Friday, Dec. 5 and 6, 1935. A preliminary list of topics to be discussed follows:

Highway Transportation Economics

Service Lives of Road Surfaces
Annual Costs of Equipment
Flow of Highway and Railway Traffic in Iowa
Highway Property Appraisal
Wind Resistance of Automobiles
Annual Highway Costs

Highway Design

Use of High Elastic Limit Steel as Concrete Reinforcement..
Tests of Stresses in Concrete Pavements
Joints in Concrete Pavements
Brick Road Experiments in Ohio
Landslides
Effects of Trees on Wind Velocities for Snow Control

Materials and Construction

Weathering Tests of Asphalts
Needed Research in Asphalts and Tars
Sodium Sulphate Tests for Soundness of Aggregates
Effect of Freezing and Thawing on Concrete With Cements of Different Compositions
Placing Pavement Concrete by Vibration
Fillers and Cushion Courses for Brick and Block Pavements

Maintenance

Survey of Maintenance Costs
Maintenance of Cracks and Expansion Joints

Traffic and Safety

The Science of Seeing
Toll Bridge Traffic Patterns
A Master Traffic Survey in Iowa
Distance and Time Required for Passing Vehicles—Photographic Method
Safety Zones
Inspection of Motor Vehicles
Accomplishments in Promoting Safety

Soils Investigations

Stabilization of Road Surfaces

View of Quarry Showing Track Layout and Hand Loading Operations

NEW MUNICIPAL ASPHALT PLANT OF CINCINNATI, OHIO

THE new municipal asphalt plant of Cincinnati, O., which was completed recently, has a number of interesting and unusual features, which make for accuracy, efficiency and economy in operation.

The entire plant is concentrated in a space approximately 35 ft. by 35 ft. by 65 ft. high. The plant is stated to be capable of producing 75 tons of hot mix per hour at 300 to 450 degrees, and without any changes except the change of heat from one furnace to the other to be able to produce 50 tons of cold mix per hour at 120 degrees.

Handling Mineral Aggregates.—The mineral aggregates required for the various types of asphalt mixtures are delivered to the plant yard in hopper bottom cars and placed over a standard track hopper. From this hopper the aggregates are conveyed by an apron conveyor to a vertical bucket elevator which is arranged at its head for diverting the materials into each of three silos. Each silo is served at the bottom by a feeder which draws the material to a belt conveyor running parallel with the line of silos, which conveyor deposits either material, or a combination of two or three materials, at a central location. From this point another belt conveyor, which is motor driven and operated from the mixer platform of the new plant, carries the mineral aggregate to the combination dryer-cooler.

The Combination Dryer-Cooler.—Figure 1 shows the Simplicity System Company's dryer-cooler arranged for producing hot or cold mix asphalt. This ingenious invention makes it possible to either dry and superheat the mineral aggregate to 300 to 450° F. for hot mix, or dry, and again cool, the aggregates to 120° F. for cold mix by simply lighting the oil burner at one end or the other. The dryer, 8 ft. in diameter by 21 ft. long, is a double shell dryer—a drum within a drum. On the hot mix operation, hot gases first enter the inner drum, travel the full length, and by a large volume of induced draft, reverse and flow between the inner and outer drums, and enter the dust collecting system before being exhausted to the atmosphere. The aggregates flow counter-currently with the flow of gases; that is, enter the dryer-cooler between the two drums, flowing first through the outer drum and then through the inner drum, discharging at the firing end of the dryer. Thus the material is dried at a low temperature in the outer drum and superheated in the inner drum.

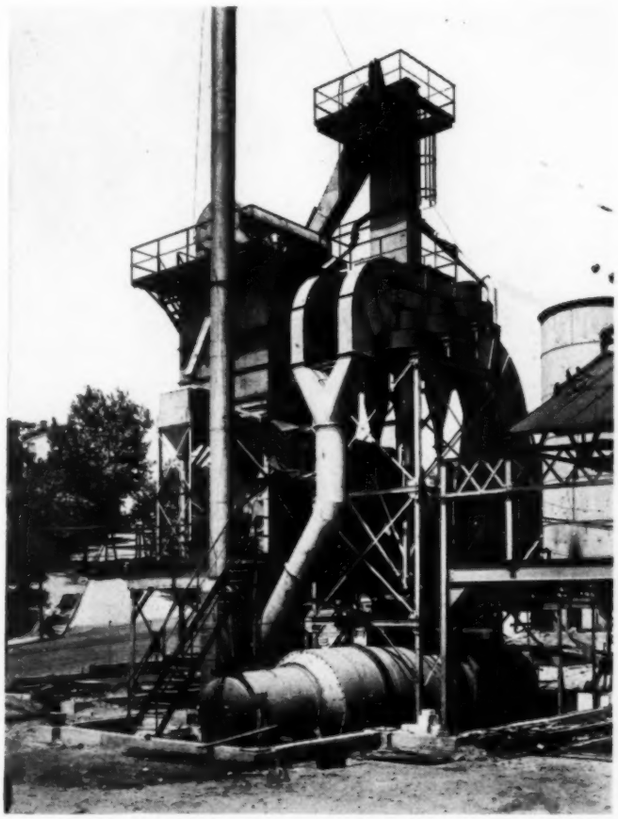


Fig. 1.—Dryer-Cooler and Dust Collecting System. Foundation for Steel Frame Structure to Enclose the Plant Also Are Shown

Fig. 2.—Opposite End of Dryer, Showing Collector and Hot Material Elevator

On the cold mix operation, the hot mix furnace is shut off, the adjustable furnace head is moved out for admission of cold air, and the furnace at the opposite end is lighted. Thus, with the induced draft, hot gases from this furnace are drawn immediately to the outer shell and at the same time cold air is drawn through the inner shell. The aggregates are then dried at approximately 250° F. until they enter the inner drum, where they are cooled to within 30° of atmospheric temperature by the large volume of air at atmospheric tem-

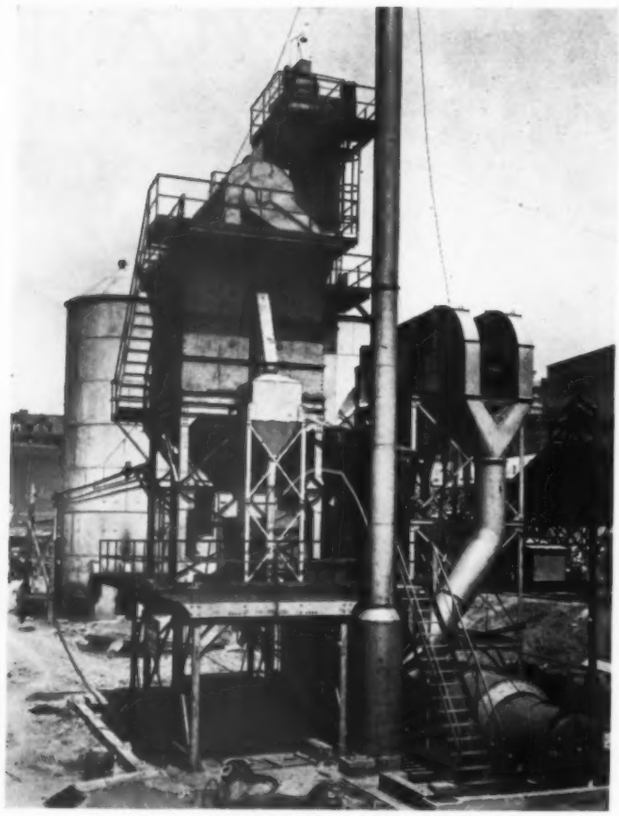


Fig. 3.—Rejection End of Screen Housing and Bin with Structural Tower

perature. The oil burning equipment was designed and manufactured by The Engineer Co., New York City.

Dust Collecting System.—Directly over the dryer (see Fig. 1), is the American Blower Corporation's sirocco dust collecting system, consisting of six No. 16 collectors. This system of dust collecting reclaims the finer particles of dust 95 per cent of which will pass a 200-mesh screen. In Fig. 2 showing the dryer from the opposite end, the American Blower Corporation's knockout collector will be seen just above the belt conveyor. The purpose of this collector is to separate the larger particles of material within the dust laden air from the finer dust which is valuable material and may be again used in certain types of hot mixes. This knockout collector is provided with an adjustable baffle gate so that the grading of the dust entering the sirocco collectors may be regulated. In general, the knockout collector takes out material from 10-mesh to 40-mesh and returns it in a uniform flow to the boot of the hot sand elevator. While the primary purpose of this dust collecting system is to do away with the dust nuisance, it further salvages material which is required for filler dust in hot mix pavements and which is worth approximately $5.00 per ton. This valuable material is salvaged at the rate of approximately 2 per cent of the volume of materials dried. Further, in connection with the salvaging of dust, is the dust container just to the right of the dryer, which is designed and manufactured by Mr. Harry Balsly, Asphalt Plant Superintendent for the city of Cincinnati. The horizontal casing running from the top of this dust conveyor over the dryer is a screw conveyor which transfers the dust from the American Blower Corporation's rotary valve located beneath the sirocco collectors. From this dust container the dust is conveyed by air handling system to either the large dust silo or directly to the dust storage bin on the new plant. The dust container is automatic in its operation, unloading itself at intervals throughout the day's operation without requiring any attention.

Hot Material Elevator.—The hot material elevator, which conveys the aggregates from the dryer to the rotary screen, is shown in Fig. 2. This is a bucket type elevator with malleable iron buckets and the chute from the head of the elevator to the screen is provided with removable manganese steel liners.

In Fig. 3 the rejection end of the screen housing is just visible above the bin. This is a rotary type screen mounted on roller bearing trunnions and is driven by roller chain from Master Electric Company gear head motor. The chain guard may be seen in the illustration. Directly beneath the screen is a chute which conveys oversize material to a 5 cu. yd. rejection bin, which is provided with a drawoff gate for unloading into trucks. Figure 3 also shows the construction of the bin and structural tower. The bin, which is 100-ton capacity, has two equal compartments.

The Mixer Platform.—Figure 4 is a view of the mixer platform, where all of the controls for automatically weighing the aggregates, liquifier, asphalt, and filler dust are controlled by one man at this central location. On each side of the operating platform will be seen a Toledo springless dial scale with photo-electric attachment. The scale to the left controls the weighing of two sizes of aggregate and filler dust. The other scale controls the automatic weighing of asphalt cement. Barely visible at the top of the picture, and just behind the angle brace, is one of the two Jeffrey-Traylor vibrating feeders. Each of the two bin compartments is served by this type of vibrating feeder which is set beneath an auxiliary bin opening. Just beneath the feeder, at the left, will be seen the manually operated bin gate lever. At the handle of this lever is a start and stop push button station. In operation, the bulk of the material is quickly dropped into the aggregate weigh hopper and cut off when the scale reads within about 100 lb. of the required capacity, at which time the bin gate is closed and the operator simultaneously contacts the starter button for starting the Jeffrey-Traylor vibrating feeder. This finishes the weighing of the aggregate, which feeding is cut off by a photo-electric control on the scale. At the extreme left of the illustration, near the dust-proof housing, the inspection door of which has been removed, will be seen the steam jacketed bottom dump type asphalt weigh bucket. A start and stop push button station is provided on the operating side of the platform, which opens a thrustor operated valve, which, through the Toledo photo-elec-

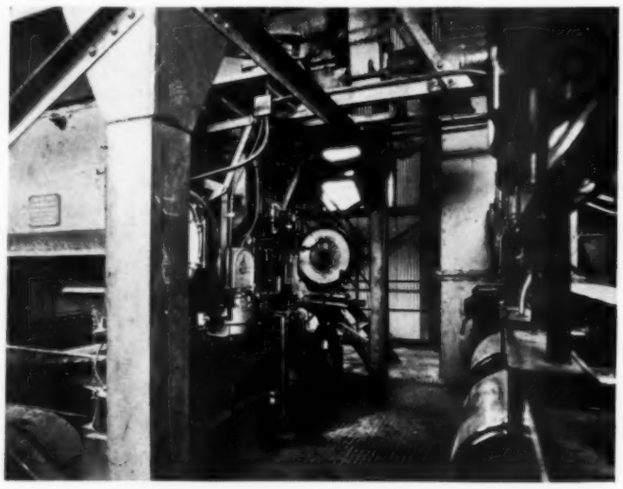


Fig. 4.—The Mixer Platform

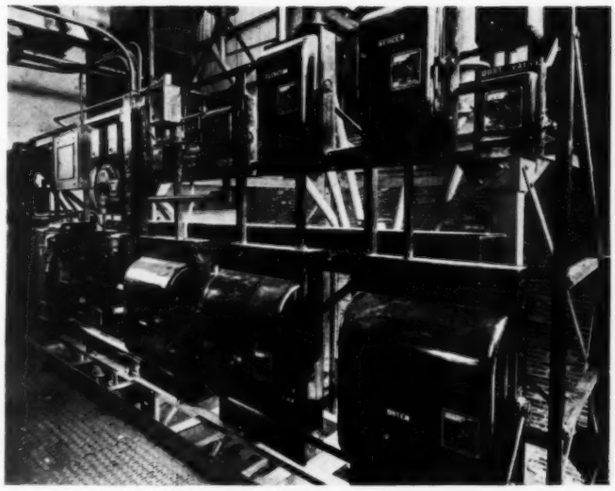


Fig. 5.—The Main Distribution Panel

trically controlled scale, is shut off when the desired amount of asphalt has been weighed. This bucket is dumped by air cylinders operating a sliding gate at the bottom of the bucket, the control for which is also located in front of the operator. Directly in the center by the controls, between the two scales, is the liquifier meter, which automatically dispenses any pre-determined quantity of liquifier, which material is required in the production of cold mixed asphalt. This device was furnished by the Bowser Manufacturing Co., of Fort Wayne, Ind. At the top center of the photograph is a rotary valve which is feeding filler dust to a screw conveyor, which is powered by the Master Electric Company totally enclosed gear head motor shown mounted on the overhung structural base.

Figure 5 shows the main distribution panel which controls each operation of the plant. Near the left of the illustration there is a series of start and stop push button stations which control the belt conveyor, dryer, elevator and screen. Drum type controllers are provided for the fan and mixer. The two rheostats shown just to the left of the start and stop push button stations are for controlling the vibration speed on the Jeffrey-Traylor vibrating feeders.

The Simplicity System Company, of Chattanooga, Tenn., the general contractors for carrying out the combined ideas of Mr. Charles E. Brokaw, Superintendent of Highway Maintenance; Mr. Wilburn E. Meyer, of the Highway Maintenance Department; and Mr. Harry Balsly, Plant Superintendent.

Highway Design in the Horse and Buggy Days

In highway design, as in all other lines of human endeavor, changing conditions have made necessary extensive modifications of standards existing a comparatively few years ago. It may be interesting to go back these "few years" and see what conditions were in the road field in the days before Ford. Mr. Roy J. Randall has done this in a paper presented at the 1935 Annual Highway Conference at the University of Colorado, from which the notes following are taken.

Forty years ago when a young man dated his girl for a ride he called for her in a buggy, powered with one horse power. This one horse may have been a black, bay or sorrel but regardless of color his sustained speed of ten miles per hour was considered quite good.

The girl was not always a blond and used little or no lip stick, rouge or finger nail color. These items may suggest changes other than in road design that have taken place with the passing time.

This was the usual type of pleasure vehicle in general use in the gay nineties, with the minor difference that often a spanking span of two horses was used and in the winter time, under good snow conditions, a cutter was substituted for the buggy.

Freight was hauled in wagons or drays drawn by two, four or more horses. Available data as to the weight of loads thus hauled and the average length of haul is very meager and the accuracy of these data was seriously questioned at the time of their publication.

These include Circular No. 19 published in 1896 by the Road Inquiry Office of the United States Department of Agriculture and Bulletin No. 49 published by the same office in 1907.

Circular No. 19 shows the following:

State	Average haul miles	Average load-pounds
Colorado	10.5	24.17
New Mexico	34.0	1584
Wyoming	40.0	2800
United States	12.1	2002

The width of right-of-way for the construction of highways to carry the traffic which I have just attempted to picture to you was generally from 60 ft. to 66 ft. In some states, for example, Illinois, the law specified that "if possible," a strip equal in width to one tenth of the right-of-way should be reserved for pedestrians on each side between the property line and the ditch. In Massachusetts, State aid roads usually had a width of right-of-way of 50 ft. except in localities where there was a possibility of space being required by an electric road, they were 60 ft., the latter being considered sufficient to accommodate a double track electric road, wagon road, ditches and sidewalks. In England, 66 ft. of right-of-way was used with 20 to 22 ft. improved in the vicinity of the more populous cities. In Holland the usual width was 38 ft. of which 14 ft. was improved. In France 26 to 66 ft. of right-of-way with from 16 to 22 ft. improved as the density of traffic required.

Considerable discussion was had concerning the economics of flattening grades and much of this is really humorous in the light of our present day knowledge. However we find this in the records: An early-day law limited the grades of toll roads to 1 in 11 or approximately 9 per cent. New Jersey state aid roads had grades of 7 and 8 per cent and one of 10¾ per cent. Grades of over 25 per cent are mentioned in connection with earth roads; however, the locations of these places are not recorded. Several macadamized city streets are noted, among which are Newton, Mass., with a number of stretches of 9 and 10 per cent grades and one 12 per cent grade 1000 ft. long; Waltham, Mass., with a 400 ft. grade at 12 per cent and another at 13 per cent. The Borough of Richmond (Staten Island), New York City, had several 10, 11 and 12 per cent grades and 100 ft. of 14 per cent and two stretches of 200 ft. each of 16 per cent and one piece 200 ft. long of 20 per cent grade.

The maximum limits of grade were dependent on the strength and endurance of a team to ascend and the skill of the driver to descend safely.

In like manner curvature of alignment was correlated to the width of the roadway and the greatest length of teams using them. Since the length of a 4-horse team and vehicle was about 50 ft., to permit such a team to keep upon a 12 ft. roadway required a radius inside the curve of about 100 ft. Wider roadways permitted shorter radius curves. So much for the theory.

EDITORIALS

More on the Use of Daylight

The adoption of Eastern Standard Time by the City of Chicago, to which reference was made in these columns last month, has been enacted by the city council, to become effective March 1, 1936. While the council voted 44 to 3 in favor of the change, newspaper opinion and public opinion have been divided, and the matter may be brought to a referendum. It is to be hoped that nothing will undo the council's action.

Few phases of everyday life permit of readjustment with as much benefit and as little coincident harm as do time habits, and to a certain extent, time measurements; but it is hard so to convince the public. Not only does the rigid groove of custom resist the change, but class jealousy rises to protest what it fears is for the other fellow. If you doubt this, read the newspaper letters and note the number of complaints that the change is planned for the golfers or the theater-goers or the stock market or the idle rich who lie in bed mornings. The predominant tone is not one of analysis or open minded consideration but of resentment.

The real question in the Chicago case is whether or not an hour of daylight is worth more near the beginning or near the end of the day's activities; and a very little consideration should show clearly that it is worth most near the end. At that time everybody is active. offices, stores, and factories are at or nearing the end of the day's work: many people are already hurrying home: housewives are getting dinner: children are through school and seeking amusement indoors or out. Only the sick and the night shift are in bed. If darkness has come, homes and work places blaze with lights.

Contrast the morning. In homes there is rising, dressing, the getting and eating of breakfast, departure for work or school: there are no lights except for these purposes: a few fortunate ones (or are they fortunate?) are still asleep. On streets and in trains crowds go to work, but the morning rush is always less concentrated, less congested, than the evening. Note furthermore that the peak rush will not come till after dawn, even under the new system. Stores and offices open at 8:30 or 9:00—shops and factories a little earlier. Chicago on Eastern time will have the same light at 8:30 that it now has at 7:30—not bright to be sure, but daylight even in mid winter. By 9:00, when a great part of business starts, lights will be unnecessary in some locations. This against total darkness before the five o'clock evening closing hour, on Central time. And let us not forget that stores are open till six.

Police and safety officials stress the point that the evening rush brings fewer accidents when it comes in daylight than when it comes in dark. In rebuttal, the opponents of "daylight saving" point to the list of early morning fatalities, quite neglecting the fact that most such accidents are the result, not of the morning hour, but of injudicious midnight celebration.

Many protests to the change cite the hardship of rising before daylight, and this, it must be admitted, is not pleasant; *but* which do you prefer—daylight during waking hours, when you can use and enjoy it or during sleep, when you can't? The writer gets up in the dark several months each year and has never found it a hardship—even when his first duty was a soft coal furnace.

Of all the benefits from "daylight saving," probably that to the children is greatest. Few get out into the light and air before school time; whatever daylight has passed has been of little or no value. In the afternoon, we all know that the youngsters stay out till dark in all but the worst of weather. And we know, too, far better than did our parents, what an hour of light and fresh air mean to a child's health. City children need all they can get, and more.

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Announcement of a Forthcoming Book of Road and Street Cost Data

ROADS AND STREETS, following the course of its predecessor, *Engineering and Contracting,* has consistently featured the publication of cost data. This practice it proposes to continue, giving due attention to both construction and maintenance.

Such data are received with interest, and are profitably used when first brought out, but very quickly become lost and totally inaccessible to the majority of potential users. This in spite of the fact that they retain their fundamental value so long as the methods on which they are based remain in use.

There is at the present time a large and growing need for a comprehensive collection of road and street data in convenient form for ready reference; and to fill this need Halbert P. Gillette, editor in chief of this magazine, and John C. Black, associate editor, have for several months been compiling material. They have assembled a mass of clippings from the columns of ROADS AND STREETS and other publications, including those of the U. S. Bureau of Public Roads. From this collection the less useful articles are now being eliminated, while others are condensed by the removal of parts not necessary to the interpretation of costs. Gillette's Handbook of Cost Data, Gillette's Handbook of Construction Cost, and certain other reference books and texts are being drawn upon for articles which are superior in their respective fields to anything more recently published. To all of this will be added hitherto unpublished data from various sources.

The editors take this opportunity of reminding readers that they always welcome reliable cost data to their columns, and that now such data will be doubly welcome if received in time for inclusion in the new book. The exact locations of the work and the names of those furnishing the data are published or withheld as requested.

The chapters will cover grading, drainage, bridges, culverts, and miscellaneous items, as well as all classes and types of road surfaces. They will treat of work done by the most modern machines, and also by hand methods and such older machines as are still in common use. The time of men and machines will be given wherever available; and there will be many time studies and analyses of machine operations.

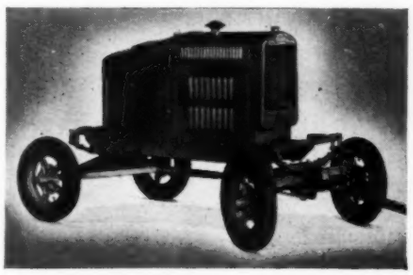
The whole, when compiled in one volume, will provide a most practical source of reference for all who have occasion to estimate the costs of road and street construction and maintenance. It is expected that it will be ready for publication early next year.

NEW EQUIPMENT AND MATERIALS

New Engine-Driven Arc Welder

A portable engine-driven arc welding machine which, it is claimed, is of particular interest to the highway field is announced by J. D. Adams Company of Indianapolis, Ind.

Since the widespread adoption of the electric welding process in the fabrication of road machinery, many highway departments and contractors have become intertested in this process for the repair of all kinds of machinery, bridges, etc., and for the building up of special structures and equipment to be found around almost every highway garage and yard. An electric welding machine (engine-driven), it is claimed, makes field repairs quick, easy and economical, and it has the further advantage of being ready to work any time or place.



Adams Arc Welder Mounted on Steel Trailer

The Adams Arc Welder is mounted on steel skids, in which form its occupies very little space in the shop during the winter "machinery overhauling" season. When required for field use the machine can either be hoisted into a truck or mounted on a steel trailer with rubber tires, as illustrated.

An exclusive feature of the Adams Arc Welder is a remote control switch in the electrode holder which enables the operator to start and stop the engine at will, though his machine may be located several hundred feet from where the operator is working. This eliminates waste of fuel and destructive engine idling between welds. This exclusive feature is considered by the welding industry as a distinct advance in welder design.

Complete information on this welding machine may be had by addressing J. D. Adams Company, Welding Division, Indianapolis, Ind.

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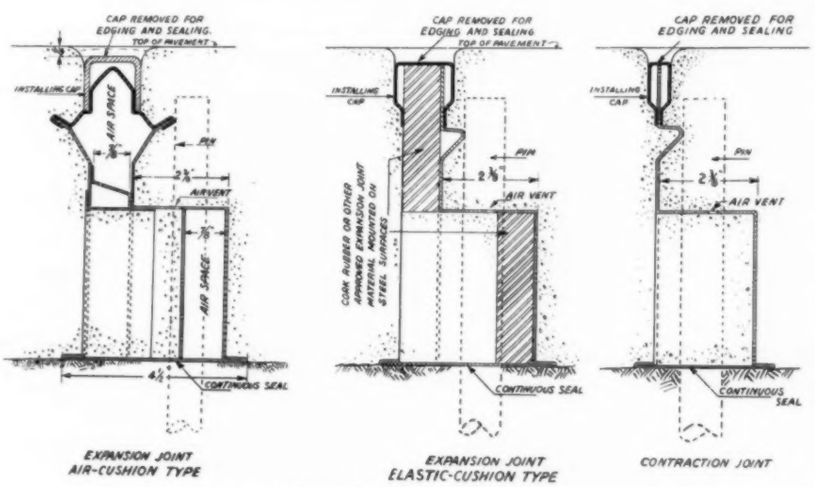
New Road Joints

Two types of transverse expansion joints, air-cushion and elastic-cushion, and a contraction joint of similar design have been developed by the Kalman Steel Corporation, subsidiary of Bethlehem Steel Corporation, Bethlehem, Pa., as a means of preserving smooth and even concrete highway surfaces and permitting free movement of the pavement under expansion and contraction.

These Kalman road joints are shop-assembled, self-contained, concrete-interlock units that come to the job complete, requiring only to be set in place on the subgrade and staked to prevent movement while concreting. Their design embodies a distinctive system of interlocking lugs and recesses formed directly in the concrete, so proportioned and spaced that the strength of the concrete is utilized to its best advantage. Bottom, top and ends are arranged to prevent entry of foreign materials into the body of the joint.

In the air-cushion type there is a ⅞-in. air space, transversely in the joint, while in the elastic-cushion type specified material such as cork, rubber or other approved expansion joint material is mounted on steel surfaces. The detail of the contraction joint embodies all the distinctive features of the Kalman interlock joint, such as bottom and top sealing and so on, but with the expansion provision omitted.

Thickened edges, crown, curb extensions and all such features to meet the requirement of good pavement design are correctly provided for in the manufacture of these complete Kalman Road Joints. Copies of descriptive folder No. 302 are available upon request.



New Kalman Road Joints

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"Caterpillar" Announces New Models, Greater Power

One of the most important new model announcements of recent years has been made by Caterpillar Tractor Co. of Peoria, Ill., introducing four new Diesel tractors, to be known as the RD-8, RD-7, RD-6 and RD-4, and a spark ignition machine called the Thirty.

The first three Diesel models succeed the Diesel Seventy-Five, Diesel Fifty and Diesel Forty and are comparable with them in everything except power. Engines in these three incorporate all the features that made the former models so popular and they achieve greatly increased power through an increase in cylinder bore from 5¼ to 5¾ in. and other refinements that have been made in the engine and fuel injection system.

Drawbar and belt horsepowers of the five new models are as follows:

	Drawbar H.P.	Belt H.P.
RD-8	95	110
RD-7	61	70
RD-6	45	51
RD-4	35	41
Thirty (spark ignition)	35	41

The RD-4 and the spark-ignition Thirty tractors, embracing many new features of design, may be compared to the former Thirty model produced by the company until 1932. Of the same horsepower, the old Thirty has been accorded tremendous popularity, shown by the fact that 25,000 of this model are now in the field. The new RD-4 and Thirty are companions in outer dimensions, chassis, transmission and tracks. Many engine parts are also interchangeable. The new machines have higher ground clearance (11⅝ in.) and less overall height (5 ft. 5/16 in.) than the old Thirty tractor. The Diesel weighs only 400 lbs. more than the new Thirty and almost 300 pounds less than the old. This reduction in pounds per horsepower is considered a major achievement in Diesel tractor design.

The RD-4 consumes only 1¼ gal. of low cost fuel oil an hour. The old Thirty tractor burns about 4 gal. of gasoline per hour and its greatest speed is 3.6 miles per hour. The RD-4 and new Thirty have five speeds forward, fifth being 5.4 m.p.h. Drawbar pull for both (the Thirty burning gasoline) is as follows: First, 7,725 lbs.; second, 5,475 lbs.; third, 4,170 lbs.; fourth, 3,195 lbs.; fifth, 1,880 lbs.; and reverse, 6,800 lbs. Speeds are 1.7, 2.4, 3.0, 3.7, 5.4 and 1.9 (reverse) m.p.h., respectively. Standard tread is 44 in. and wide gauge models, 60 in.

Especially suited to work in small fields, the RD-4 will pull five 14-in. plows at 3 miles per hour under most conditions; will handle many grading and highway main-

tenance tasks, and is also expected to take an important place in industrial use. Its Diesel engine is of 4-cylinder, 4-cycle design, having a bore and stroke of 4¼ in. by 5½ in., and a governed speed of 1400 r.p.m. A compact 2-cylinder gasoline starting engine of the opposed piston, horizontal type is mounted at the rear of the Diesel. The starting engine speeds warming up the Diesel by circulating water through connecting manifolds. Engine and pump parts, speed change gears, flywheel and steering clutches are easily accessible for inspection or servicing. The latter three may be removed individually after taking off the transmission case cover.

High quality materials and workmanship have been maintained throughout, the announcement states. Cylinder liners are of heat-treated chrome nickel alloy iron cast in the company's foundry. Engine construction is similar to all past Diesel models manufactured by the company. Individual fuel pumps have been retained. The drawbar is pivoted farther forward than in former models, permitting more flexibility and added power on turns. Power take-off is from the lower shaft of the change gear set, but is mounted at standard S.A.E. height from the ground.

Except for addition of the new Thirty, no change in the company's line of gasoline tractors is announced. Present models are the Twenty-Two, Twenty-Eight, Forty, Fifty and Seventy tractors.

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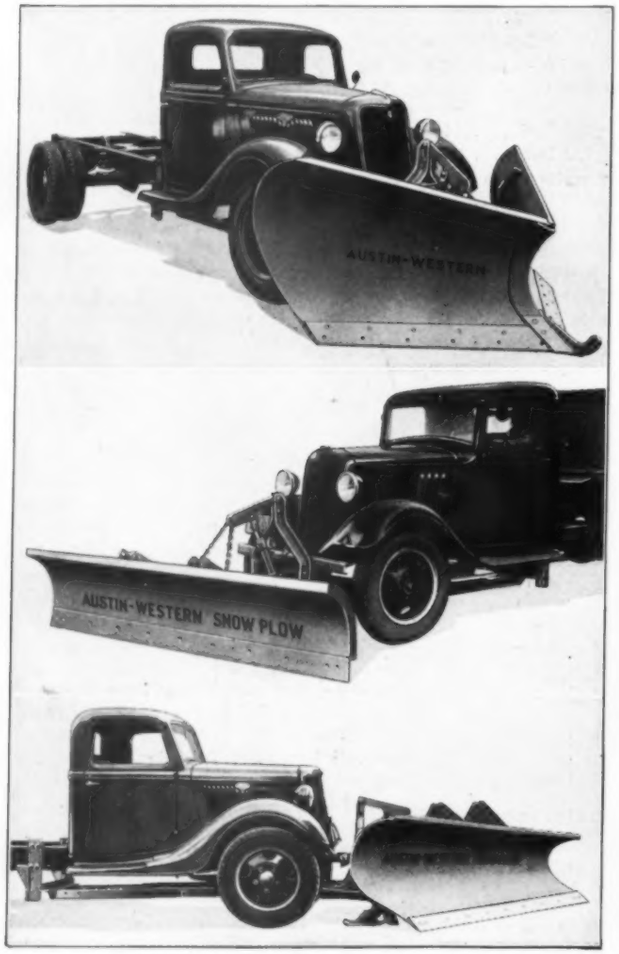
New Line of Snow Plows

A new line of plows, built to match the power output of trucks in the Ford and Chevrolet class, has just been announced by the Austin-Wheeler Road Machinery Co., Aurora, Ill.

According to this concern they are most carefully designed and fabricated to secure better balance and greater strength, and they are curved to handle a maximum volume of snow with a minimum expenditure of power.

All excess power consuming weight has been avoided to increase truck speed, to prevent injury to front of truck, and to permit easy and quick attachment or removal as desired.



New Line of Austin-Western Snow Plows

The V-type (top, see illustration) reversible straight blade (center) and one-way tapered blade (bottom) use the same frame and are interchangeable. Features available on these plows include rubber tired, caster wheels, safety spring release, and means to adjust pitch and plowing angles of blades.

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New Four Rear Wheel Drive for Light Trucks

A new four rear wheel drive unit for Ford and Chevrolet 1½ ton trucks that is stated to greatly increase pay-load capacity and reduce operating costs has been brought out by Thornton Tandem Co., 5165 Braden St., Detroit, Mich.

The secret of successfully applying greater driving power equally to each of the four rear wheel is said to be in the location of the transfer case—midway of the two driving axles. And the transfer case gearing doubles the speed in the truck transmission case, too providing 8 speeds forward, 2 reverse.

Truck Equipped with Thornton Dual Ratio Four Rear Wheel Drive

Among other advantages claimed is a correct wheelbase for every body length and type. This permits the location of the load directly over the two rear axles, thus providing equal load distribution on the four rear wheels. The load on the front axle is held within the rating specified by the truck manufacturers. The forward driving axle follows the lead of the front wheels, allowing the truck to turn directly from a flush curb contact, and to turn and back as easily as the conventional two-wheel-drive truck of the same wheelbase.

The Thornton double spring and shackle design in conjunction with the third differential mounted in the transfer case is stated to provide lower center of gravity and better balance—permitting higher loads and greater speeds even on sharp turns. Axle fight and tire scrubbing are eliminated.

Sixteen points of mechanical flexibility greatly reduce body sway, road shock and brake strain—resulting in much easier handling, greater riding comfort, longer chassis and tire life. Each of the wheel is always on the ground under every road condition wherever the truck can move—each wheel travels independently of the others. Six-wheel brakes reduce chances of skidding, increase safety and give greater tire-to-road contact.

Another advantage pointed out is the easy conversion of Thornton-equipped trucks from one kind of service to another.

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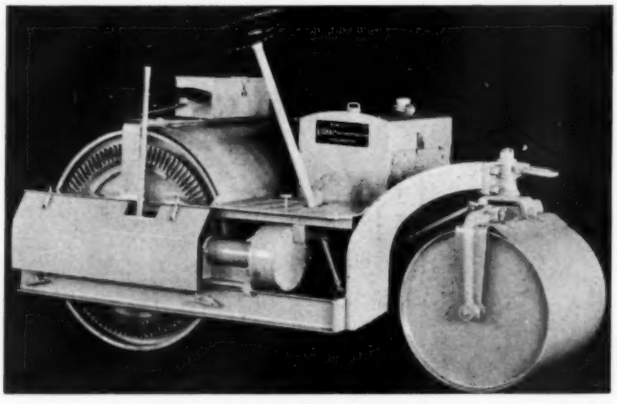
New 2-Ton Road Roller

A new 2-ton road roller has been placed on the market by C. H. & E. Manufacturing Co., 120 E. Mineral St., Milwaukee, Wis. The roller has been developed for use in rolling sidewalks



New C. H. & E. 2-Ton Roller

along highways, playgrounds and various other types of light rolling work as well as for light patching work on roads and streets.

The roller has only one gear reduction and has separate clutch and drive pinion for both forward and reverse speeds. The specifications include the following: Weight, 3,000 lb. with rear roller empty, 4,000 lb. with rear roller filled with water. Rear roller: 34 in. wide by 36 in. in diameter. Front roller: 24 in. wide by 24 in. in diameter. Overall length: 7 ft. 8 in. Overall width: 3 ft. 9 in. Compression: 65 lb. per lineal inch, rear roller empty; 95 lb. per lineal inch, rear roller filled. Speed: One speed forward and one reverse, 6 m.p.h. maximum. Engine, Le Roi 4-cylinder radiator cooled, 14 h.p. at 1,900 r.p.m.; Wisconsin 4-cylinder air cooled, 14 h.p. at 1,900 r.p.m. Clutches: Twin disc double plate, 4 friction discs.

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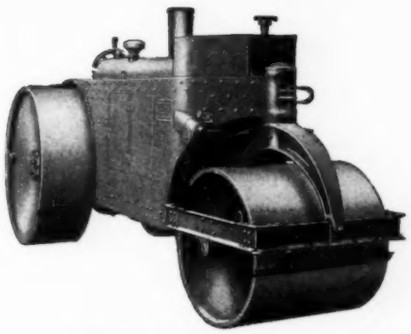
New Snow Plow and Blade Wing for "Caterpillar" Auto Patrols

A new one-way snow plow and a winged blade extension for its three Auto Patrol models has been announced by Caterpillar Tractor Co. of Peoria, Ill. These attachments are designed for moderate snow removal, to patrol highways during heavy storms, work mountain roads and clear city streets. The equipment clears a 10-ft. swath, opening one-way traffic in a single operation.

Accurate and fast blade adjustments, the announcement states, allow plow and blade to work close to the road, cleaning the snow right down to the surface to prevent ice formation.

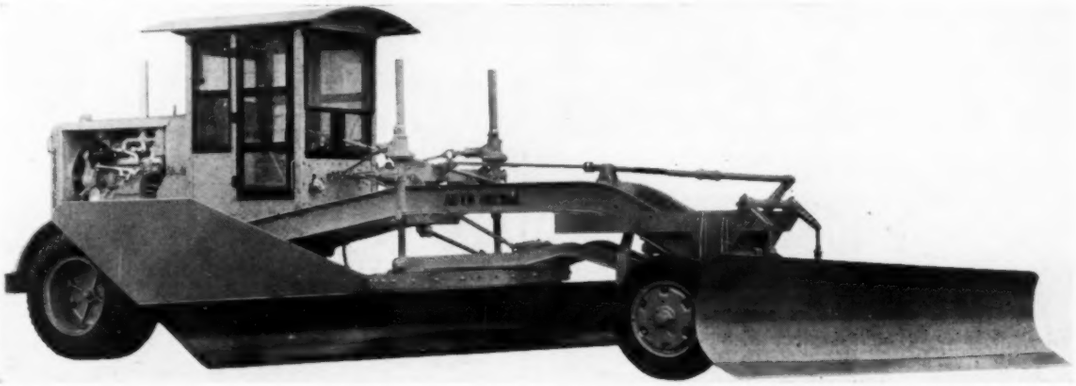


Davenport Diesel Powered Roller

Strictly one-man operation is claimed for these rollers, which have four speeds forward and four reverse, with a speed range of .92 to 5.02 miles per hour.

The wheels are of all-steel, heavy welded construction, accurately machined round and true. All wheels are designed to receive liquid or solid ballast to permit temporary increases in weight where circumstances demand.

Already, in addition to several furnished to American contractors, the Mexican government purchased six Davenport Diesel rollers and has placed them in service on the extensive Mexican highway program.



New Snow Plow and Winged Blade Extension for "Caterpillar" Auto Patrols

The plow is a self-contained unit that can be quickly attached to the front axles of the "Caterpillar" Diesel No. 11 and No. 10 Auto Patrols. The power-control shaft provided for the scarifier operates the plow, which is 8½ ft. long and cuts a swath 6½ ft. wide. Height is 30 in. and maximum lift 13 in. Runners and spring suspension permit the plow to float over rough or uneven roads.

The extension and wing are attached to the right end of the Auto Patrol blade, and widen the plow cut to 10 ft. The wing pitch is adjusted by means of a telescoping shaft and hinges. Height, including blade, is 4½ ft. The wing itself is 7 ft. 8 in. long. Both attachments are of heavy duty construction and are ruggedly reinforced. The new equipment will be offered in addition to the V-type snow plows which have been available for "Caterpillar" Auto Patrols in the past.

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Davenport Diesel Powered Roller

A new Diesel powered roller has been announced by the Davenport-Besler Corporation of Davenport, Ia.

Davenport Diesel rollers are furnished in 10 and 12-ton units. They are powered with Caterpillar D-6100 Diesel engines and have embodied in them such other Caterpillar standard parts as transmission gears, clutch, differential, and power take-off for steering and for operating such accessories as scarifier, grade blades, sprinkler system, ironer roller, etc.

The bull driving gear is centrally located, is completely housed in the transmission case, is sealed against dust and grit, and runs in oil—a feature which, it is claimed, combines with the central application of power to the drive shaft to insure longer life.

Worthington Portable Compressors Now Mounted on Standard Trucks

The smaller sizes of Worthington Aero 2-stage portable compressors can now be mounted on standard trucks, according to a recent announcement of the Worthington Pump & Machinery Corporation, Harrison, N. J.

The compressor is driven through a power take-off on the truck shaft, through a Worthington Multi-V-Drive by the truck

Typical Installation on Truck

engine. It is rigidly mounted on the truck frame and belt tension is maintained by a ball bearing idler. The compressor is a three-cylinder air-cooled unit with air-cooled intercooler. It has Tim-

ken tapered roller main bearings, force-feed filtered lubrication throughout, and is equipped with Worthington patented feather valves.

Mountings can be accommodated to any standard truck chassis and any standard or special body type which may best suit the purchaser's requirements.

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Traffic Line Markers

A wheel marker and a hand marker for traffic lines have been added to the products of the Municipal Supply Co., South Bend, Ind. These markers will mark lines on any kind of hard surface and are suitable for applying any color paint, also hot or cold asphalt. The paint feeds by gravity. A patented brush mechanism provides for cleaning the surface before painting and applies the paint in a smooth, uniform manner. Patented self-adjusting side plates produce a straight-edge stripe. The wheel marker has a paint container with a capacity of 5 gal. It makes a standard 4-in. stripe. The chassis consists of structural steel frame; welded. Wheels—disc type, 10 in. diameter, 1¼ in. cushion rubber tires, ball bearing. Swivel caster disc type wheel, 5 in. diameter, 1¼ in. cushion rubber tires, ball bearing.

The South Bend Wheel Traffic Line Marker

The hand marker has a paint container with a capacity of 3 qts. It makes a standard 4-in. stripe.

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New Ditcher Powered With Diesel Engine

Production of a new Diesel-powered trench excavator is announced by the Parsons Co., manufacturers of a complete line of this type of machinery at Newton, Ia. This machine is known as Model No. 48.

The new product is powered with a 102 h.p. 6-cylinder "Caterpillar" Diesel engine. The ditcher is also available with 3- and 4-cylinder Diesel engines of the same make. An enviable record is claimed for No. 48 over several years of production, and now with the incorporation of the Diesel engine and its well known economy, added reliability and power, new successes are forecast.

Standard digging equipment is for 18 ft. depth and 48 ins. width, but attachments enable it to dig both wider and deeper. The machine is semi-crawler mounted, and the drive sprocket shaft is fitted wtih a differential gear permitting the outfit to steer readily under working or traveling conditions.

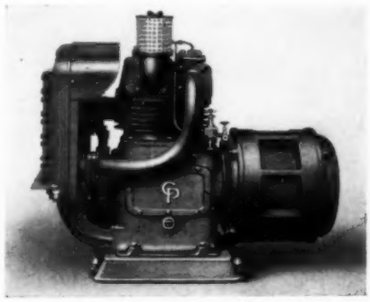
The conveyor is of the reversible type and can load at either side if so required. Twelve digging speeds are provided, through simple sprocket changes. Total weight of Model No. 48 is 60,000 lbs.

New Two-Stage Air Compressors

A new line of two-stage, air-cooled air compressors has been brought out by the Chicago Pneumatic Tool Co., 6 East 44th St., New York. These compressors are stated to embody many refinements and improvements which are the result of the company's more than 30 years' experience as air compressor builders.

Important features of the compressors include: Large valve area and posts; inlet valve unloading system; force feed lubrication; full-floating piston pins; simplate valves; only one connecting rod on each crank pin.

Only two air cylinders are used on the two smallest sizes and four on the larger sizes, cast in pairs. Their vertical, in-line arrangement permits using a separate crank pin for each



connecting rod, greatly facilitating crank pin bearing adjustment, locates all cylinders in the direct path of the blast of cool air from the fan, and simplifies the piping. The low pressure and high pressure assemblies are accurately balanced and the crankshaft carefully counterbalanced. An air-cooled, finned intercooler, with sectionalized core and served by a fan "V" belt driven from the compressor crankshaft, cools the air between stages to a temperature within a few degrees of the low pressure intake temperature.

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New P&H Bantam Weight Trailer

Low center of gravity and ease of loading and unloading have been stressed in the new trailer unit especially designed for the P&H Bantamweight excavator introduced earlier this year by the Harnischfeger Corporation of Milwaukee, Wis.

Loading is greatly simplified by removing the front axle and placing the ramp blocks to allow the machine to crawl above the

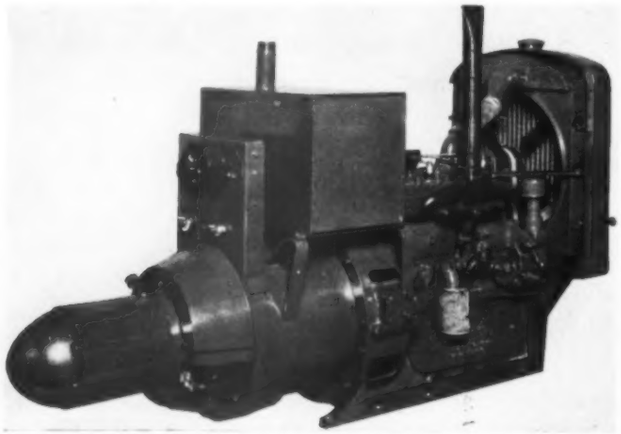
Excavator Mounted on Trailer

frame, the front of which is then hoisted with the dipper so that the front wheels may be positioned as the machine settles onto the trailer. The process is reversed in unloading. It is stated an average of only ten minutes is required for loading; ten minutes for unloading.

With four dual wheels and a wheelbase of 174 in., the unit has a turning radius of only 30 ft. Swift travel is made safe with modern mechanical brakes on rear wheels as well as an additional emergency hand brake. With its extremely low center of gravity, the unit can be towed safely even on highly crowned roads. Main frame members are H beams of Man-Ten steel for strength and lightness. According to officials of the company, this unit is the most practical, low-cost trailer they have ever built.

New Engine-Driven Welder

A new 200-ampere special engine driven "Shield Arc" welder has been announced by the Lincoln Electric Co., Cleveland, O. This new model, known as the "200-ampere Shield Arc Special," supplies a uniform current for welding with bare or heavily coated shielded arc type electrodes in all sizes up to ¼ in. The welding current range of this new machine is from 60 to 250 amperes. Its generator is the single operator variable voltage type with completely laminated magnetic circuit and equipped



New Lincoln "Shield Arc" Welder, 200-Ampere Special Engine Driven Type

with interpoles. Requires no external reactance or stabilizer. The patented Lincoln dual control of welding current is provided by adjustment of both series and shunt fields. Separate excitation of the generator shunt fields is supplied by an exciter connected on the generator end of the unit. A generator field rheostat and a current regulating switch are mounted in vertical position on a "dead-front" steel control panel. Electrode and ground cable connections of the wing nut type are also in an easily accessible position.

The welder is powered by a Waukesha 4-cylinder engine which delivers 23 h.p. at 1,400 r.p.m., the speed at which the welder is operated. A gear driven governor maintains proper engine speed at all load conditions. Engine is equipped with standard high tension magneto and vertical type carburetor with air cleaner. Gasoline tank of ample capacity for a full day's operation is mounted over the generator. Engine is direct connected to the generator shaft. Due to this close-coupling feature, the unit is compact and weighs only 1,078 lb.

New First-Aid Kit

A new first-aid kit, designed to meet the specifications of leading industrial medical directors, has been adopted as standard by the Standard Oil Co. of New Jersey and other large American industrial companies.

The special feature of this new kit, which is known as the "Brac-Kit" and was developed by the Davis Emergency Equipment Co., 55 Van Dam St., New York, is that it can be permanently installed in a given place, but its contents are instantly available in emergencies and are protected from contamination and damage when treatment is being applied.

The kit consists of two baked enamel steel cases, an outer case which can be permanentaly attached to a wall by means of screws, and an inner case which is normally kept inside the outer, where it is held in place by a simple lock. When needed, the inner case can be unlocked by a twist of the handle and carried, with all necessary first-aid supplies, to the scene of the accident.

The Brac-Kit contains ten D-carton first-aid units, each of which holds enough material to serve for several treatments. The exact assortment depends upon the industry in which the kit is to be used, but a widely accepted assortment is comprised of adhesive plaster, gauze compresses, individual swabs of Isodine (the newiodine antiseptic), individual tubes of Tannoid (tannic acid treatment for burns in a water-soluble jelly), ammonia inhalants (for fainting), eye dressings, and a tourniquet.

New Industrial Locomotive Powered With Ford V-8 Engine

The Brookville Locomotive Company of Brookville, Pa., builders of Ford-powered locomotives since the early days of the old Model "T," is now using the powerful yet relatively inexpensive Ford V-8 engine in a new series of locomotives ranging from 2½ to 6 tons in weight. These locomotives also employ the Ford four-speed truck transmission and the new Ford heavy duty truck clutch—all of the Ford assembly being installed without alteration to permit servicing with standard Ford replacement parts at any authorized Ford dealer.

New Brookville Locomotive

The power is transmitted efficiently through the Brookville reverse, which makes all four forward speeds also available in reverse. Other features of the locomotive include: steel-tired drive wheels, which increase traction by 25 per cent; dual-spring journal suspension, which permits negotiating poor track at relatively high speed; Timken bearings; neatly rounded cast steel endsills; structural steel frame; five-pocket link-and-pin couplers, and all-steel cab. Models are made for any track gauge. Catalog BV-8 describes the equipment in detail.

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WITH THE MANUFACTURERS

Rief Now General Purchasing Agent for Universal Atlas Cement

Frank J. Rief, purchasing agent for the Chicago district of the newly formed Carnegie-Illinois Steel Corporation, has also been appointed general purchasing agent for the Universal Atlas Cement Co., another subsidiary of the United States Steel Corporation, to take effect Nov. 1. He will succeed W. H. Dutcher, purchasing agent, who has been with the cement company for over 30 years and who asked to be relieved of his duties. Mr. Dutcher has made application for a pension under the Steel Corporation's plan. Mr. Rief has been connected with the corporation for 23 years, beginning his work at the South Chicago plant of the Illinois Steel Co. In 1916 he was transferred to the purchasing department of the company in its Chicago office. In 1918 he was appointed buyer; in 1924, assistant purchasing agent, and in 1930, purchasing agent. In addition to his work with the Carnegie-Illinois Steel Corporation he is also purchasing agent for other corporation subsidiaries, including the Scully Steel Products Co., Gary Land Co., United States Fuel Co., and Lafayette Fluorspar Co. The consolidation of the Universal Atlas Co.'s purchasing department with that of other subsidiaries is in line with the corporation's new policy of unification of activities.

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R. C. Larkin Co. Appointed Distributor on Thew and Universal Crane

The Thew Shovel Co. and the Universal Crane Co., Lorain, O., announce the appointment of R. C. Larkin Co., 3900 S. Wabash Ave., Chicago, Ill., as distributors for northeastern Illinois. They carry complete spare parts and service facilities are available.

Republic Steel's Pittsburgh District Sales Offices Moved

Effective Thursday, October 10, according to an announcement by N. J. Clarke, vice president in charge of sales, the Pittsburgh district sales office of Republic Steel Corporation were removed from Fourth and Bingham streets, S. S., to 1832 Oliver Building, Pittsburgh, Pa. The phone number of the offices in the Oliver Building is Grant 2425. F. M. Welsh continues in charge of the office, assisted by his present staff. The Union Drawn Steel Co., a Republic subsidiary, will move into an adjoining suite in the Oliver Building. W. C. Gullyes, district sales manager, will be in charge.

Pittman Tractor Co. Now Distributors for Chain Belt

The Chain Belt Co. of Milwaukee, Wis., has announced the appointment of J. D. Pittman Tractor Co., 520-30 N. 28th St., as its exclusive distributor of Rex Construction Equipment in the Birmingham area. The J. D. Pittman company was organized in 1927 and its officials have been identified with the construction machinery industry in the vicinity of Birmingham for many years. J. D. Pittman, president of the firm, is well known in the machinery industry and has had a great deal of experience in the construction field.

Van Doorn Retires from Universal Atlas

A record of nearly a third of a century's service ended a few days ago with the retirement of J. C. Van Doorn, Sales Manager, Minneapolis, of the Universal Atlas Cement Co., a subsidiary of the United States Steel Corp. After more than 32 years' connection with the company, he asked that he be relieved of further duties and has applied for pension under the rules of the company. Mr. Van Doorn began his work in 1903 as sales agent in St. Louis, the company at that time being the cement department of the Illinois Steel Co., another Corporation subsidiary. In 1907 he was made Northwestern sales manager, Minneapolis, and in 1928, sales manager. D. S. Day, former assistant sales manager, will succeed Mr. Van Doorn as sales manager. Mr. Day has been with the Universal Atlas company for 28 years, of which 23 years have been spent in Minneapolis.

Patten Tractor & Equipment to Have Larger Quarters

The Patten Tractor & Equipment Co., 431 S. Jefferson St., Chicago, Ill., has leased the Carlson Forging Co. plant at 1056 N. Kolmar Ave., Chicago, with occupancy planned for Dec. 15, 1935. Extensive alterations are to be made immediately. Property is served by C. & N. W. switch track. For the past twelve years Mr. Patten has acted as distributor of "Caterpillar" tractors and road machinery, as well as other related lines, and is well known to the contracting trade in Northern Illinois. A considerable expansion in organization and increased volume of sales have made this removal necessary. In its new location the Patten Tractor & Equipment Co. will have a floor area in excess of 20,000 sq. ft., making it possible to carry a very complete floor and display stock. Service and parts department facilities will be greatly enlarged and improved, and various features will be installed for the convenience and comfort of customers. Hart & Whetston, One North La Salle St., were the brokers representing all parties in the transaction.

Worthington Enlarges Its Buffalo Works

The Board of Directors of the Worthington Pump and Machinery Corporation has authorized the construction of an additional machine shop building at its Buffalo, N. Y., works, this extension to cover a floor area of 75,000 sq. ft. The new building will supplement the present capacity of the Buffalo works and will add materially to the plant facilities for the manufacture, assembly and testing of its products. The local management is now proceeding with the work and it is expected that the building will be ready for occupancy about the first of the coming year.

Faatz Now Baltimore Branch Manager for Gar Wood

Stephen R. Faatz, manager of Gar Wood Industries Los Angeles branch, has arrived in the East to become branch manager for the same company at Baltimore, Md., succeeding George F. Head, designed. John B. Work of the Los Angeles office will take over the duties of "Steve" Faatz on the west coast.

Liebich Is New Detroit Manager for P&H

The Harnischfeger Corporation of Milwaukee announces the appointment of Frank Liebich as district manager in charge of the company's operations in the Detroit area. Mr. Liebich, who moves to Detroit from the corporation's Chicago office, will have charge of the complete line of products, including excavators, cranes, welders, hoists, motors, lighting plants and brewery equipment. Since entering the Harnischfeger Industrial Sales Division in 1924, Mr. Liebich has handled several of the country's largest installations of overhead traveling cranes.

Frank Liebich

Build New Addition to Ryerson Jersey City Plant

Joseph T. Ryerson & Son, Inc., Chicago, Ill., recently completed a new extensive addition to their Jersey City plant, making available an additional 45,000 sq. ft. of floor space for the stocking of steel and allied lines.

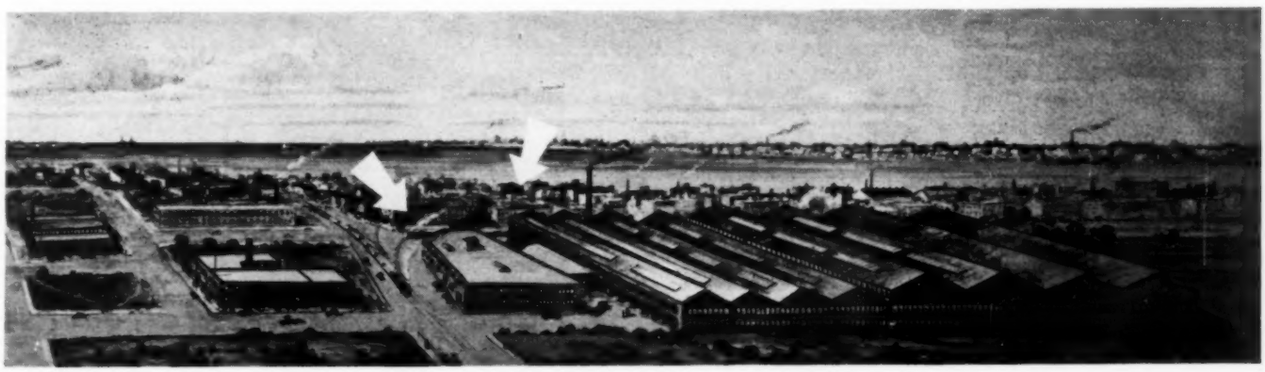
The new warehouse, a 2-story brick building, is heated throughout and has the latest equipment for the storing and handling of the finer steel products. Special racks keep the material in good condition and permit quick and easy selection of any grade or size. The heating system holds the temperature at a uniform degree, preventing any condensation of moisture or sudden change that would affect the quality and finish of special steels.

Stocks are being rapidly increased. More than 1,700 new sizes and kinds of steel have already been added, making a greatly increased steel service immediately available to the eastern area.

Joseph T. Ryerson & Son, Inc., operate a total of ten large and complete steel service plants in the principal industrial cities of the country.

Each plant is known for stocking a wide range of steel products with unusually good facilities for preserving the quality and finish of the finest products. But perhaps the most outstanding has been the Ryerson reputation for accuracy and speed of delivery.

The business was founded in 1842 on this primary principle of steel plus speed, which has been well maintained during their ninety-three years of business.



Jersey City Plant of Joseph T. Ryerson & Son, Inc. Arrows Indicate Location of New Addition

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Published Monthly by the
GILLETTE PUBLISHING COMPANY
400 West Madison Street,
Chicago, Illinois
Telephone State 5161

Entered as second-class matter June 25, 1931, at the post office at Chicago, Ill., under the act of March 3, 1879. 25 cents a copy. Annual subscription, $2.00 in the United States; Foreign and Canadian, $3.00 for 1 year, $5.00 for 2 years. Copyright, 1935, by Gillette Publishing Co.

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Vol. LXXVIII DECEMBER, 1935 No. 12

CONTENTS